

Subclinical Atrial Tachyarrhythmias: Implantable Devices and Remote Monitoring

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Abstract

Atrial fibrillation (AF) and Atrial Tachyarrhythmias (AT) are the most common clinical arrhythmias and their worst issue is a well-recognized correlation with ischemic stroke. High incidence of “subclinical” AF/ATs has been demonstrated in several trials (TRENDS, ASSERT, CRYSTAL AF, EMBRACE) in patients with both cardiac implantable electronic devices (CIEDs) and external loop recorders. Moreover, a relationship between device-detected AF/ATs and stroke risk has been observed in the same studies. However, while the net clinical benefit of the antithrombotic treatment is well established in patients with “clinical” atrial fibrillation, there may be a lower benefit in patients with device-detected arrhythmias. Subclinical AF/ATs may be considered as a marker of stroke risk rather than the proximate cause and their burden may be used in combination with CHA₂DS₂-VASc and HAS-BLED scores to identify high-risk population who deserves anticoagulation.

Today the remote monitoring associated with the CIEDs is effective in the early detecting of AF/ATs by avoiding delays in the therapy evaluation, as demonstrated by several trials (TRUST, CONNECT, COMPAS). However clinical evidence for stroke risk reduction by remote monitoring is still awaited; the recent trial IMPACT failed to demonstrate that the handling of the anticoagulation therapy guided by device-detected ATs and remote monitoring improves the patients’ outcome.

The challenges for clinicians are to deal with the huge data entry, to define new organizational models, to improve device patient management and to continuously update AF guidelines in according to the great amount of data offered by the new technology.

Introduction

Atrial fibrillation (AF) and Atrial Tachyarrhythmias (AT) are the most common clinical arrhythmias.¹ They have been associated with compromised hemodynamics, heart rate irregularity, uncontrolled ventricular rate and lower exercise capacity.² However their worst issue is a well-recognized correlation with ischemic stroke.^{3,4} These adverse events due to AF or ATs are common and frequently devastating. AF is known to increase the risk of stroke up to 5-fold and the risk of mortality up to 2-fold; 15% of all strokes are caused by AF.⁵ Anticoagulant therapy can reduce the risk of stroke by 60-70%.^{4,6} Therefore the focus has to be moved on the detection of subclinical AF episodes and, possibly, on their correct quantification, especially in patient at high thromboembolic risk. However, this task results difficult due to the often paroxysmal and asymptomatic nature

of these arrhythmias.⁷ AF/ATs may go undetected with the use of traditional monitoring techniques (table 1) and the patients often do not report any symptoms. AF can be asymptomatic in up to 30-40% of cases.^{2,4} Consequently many patients with subclinical AF/ATs may suffer ischemic strokes which are defined as “cryptogenic”: it is known that embolic risk in AF is independent of symptoms.⁸ Subclinical atrial arrhythmias may be unmasked only with a more aggressive monitoring technique. Recently, an high incidence of subclinical AF and ATs has been demonstrated thanks to the cardiac implantable electronic devices (CIEDs),^{9,10} Pacemakers (PMs) and implantable cardioverter defibrillators (ICDs) should be seen not only as therapeutic devices but also as diagnostic tools which can prevent serious adverse events, especially thromboembolic ones. In addition implantable subcutaneous cardiac monitor (ICM) can be used to allow continuous monitoring over extended periods of time. This may lead to a more patient-centered approach: the anticoagulant therapy can be adjusted for each individual by considering both the presence and the duration of specific arrhythmic episodes as well as clinical risk scores.

Key Words:

Atrial Fibrillation, Atrial Tachyarrhythmias, Cryptogenic Stroke, Remote Monitoring, Cardiac Implantable Electronic Devices.

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Relation Between Subclinical Device-Detected Atrial Tachyarrhythmias And Cryptogenic Stroke

Cryptogenic strokes account for about 20% of all ischemic strokes.² Patients with cryptogenic strokes are usually treated with antiplatelet

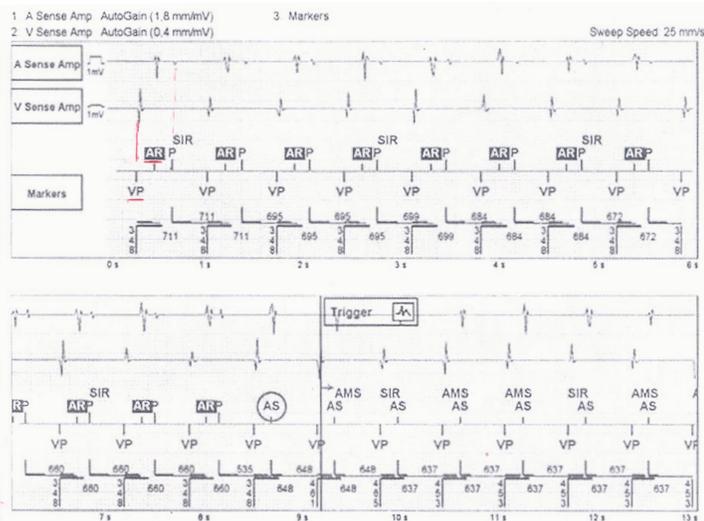


Figure 1 Episode of inappropriate mode switch due to repetitive non-reentrant ventriculoatrial synchrony (RNRVAS). See text for detailed description of the phenomenon

therapy, but they have an high recurrence rate of cerebral ischemic events. Moreover, the etiology of a subsequent stroke episode can be different from the first: for example 10-15% of patients with a first atherothrombotic event suffer a recurrent cardioembolic stroke (mainly caused by AF).⁸ This background underlies the importance of a comprehensive approach involving the screening for subclinical AF/ATs since they are a possible cause of “idiopathic” cerebral ischemic events.

Recent studies have observed the relationship between device-detected AF/ATs and stroke risk. The TRENDS⁹ trial was a prospective, multicenter observational study that enrolled 2486 patients after CIED implantation (pacemakers or defibrillators with an implanted atrial lead), all aged >65 years and with >1 risk factor for stroke (mean CHADS2 was 2.2). Patients with and without prior AF were also included. Device-detected AF/AT was defined as any Atrial High Rate Episode (AHRE) >175 bpm lasting at least 20 seconds, further refined by device-specific algorithms. Subclinical AHREs were diagnosed in 45% of 1988 patients without a documented history of prior AF. A daily AF/AT burden >5.5 hours (defined “high burden”) appeared to double the thromboembolic risk in the following 30 days with an annualized thromboembolic event rate of 2.4%. The risk remained increased even after the adjustment for other risk factors. The rate of thromboembolic events observed in “high burden” AF/AT group of TRENDS was, anyway, far below from the 4-4.5% annual rate expected from AF patients with average CHADS2 score ≥ 2 .^{2,3,4} The annualized thromboembolic event rate was 1.1% for either subsets with “zero” or “low” AF/AT burden. However the difference in hazard ratio (HR) between “low” and “high” burden AHRE groups was not statistically different.

The ASSERT trial¹⁰ was a prospective, multicenter, observational study designed to evaluate if subclinical episodes of AHREs can be associated with an increased risk of ischemic stroke, in patients without previous evidence of AF. 2580 patients with an implanted pacemaker (n=2451) or defibrillator (n=129), and an implanted atrial lead, were enrolled and monitored for 3 months to detect subclinical atrial tachyarrhythmias and for a mean of 2.5 years for the primary outcome of ischemic stroke or systemic embolism. There was a

substantial incidence of subclinical (asymptomatic) AF/ATs. These arrhythmias were detected in 10.1% of patients within the first 3 months after implantation and at least once in 34.7% of the patients during a mean follow-up period of 2.5 years. The second major finding of the study was that subclinical ATs were independently associated with an increase, by a factor of 2.5, in the risk of ischemic stroke or systemic embolism and this risk was independent of other risk factors. The annualized thromboembolic event rate has been found equal to 2.1% in the subgroup with CHADS2 score >2 (similar to TRENDS). The risk of ischemic stroke or systemic embolism associated with ATs before 3 months was 13%, which is similar to the one associated with clinical atrial fibrillation reported by previous studies. The study also suggested that the risk of stroke was higher when episodes of subclinical ATs were of longer duration (AHRE >190 bpm lasting >6 minutes), but the study was underpowered for this analysis. Anyway the incremental stroke risk has been observed for longer and more numerous subclinical episodes. Subclinical AHREs have been reported 8 times more common than clinical (symptomatic) AF.

Data from TRENDS and ASSERT are also supported by several smaller prospective trials which evaluated the relationship between AHREs and embolic events in patients with PMs and ICDs. Capucci et al.¹¹ found that in 725 patients with dual-chamber PMs AHRE lasting >5 minutes did not significantly increase embolic risk, whereas episodes >24 hours did (odds ratio 3.1). Botto et al.¹² analyzed embolic risk by combining duration and burden of AHREs with CHADS2 score. 568 patients with a dual-chamber pacemaker were followed for the first year after implantation and stratified by using a combination of AHRE burden and CHADS2 score. Separate populations with different stroke risk emerged: in patients with CHADS2 score >1 and cumulative AHRE >24 hours and in those with CHADS2 score ≥ 2 and AHRE >5 minutes the annualized thromboembolic event rate was found as high as 5%.

Subclinical atrial tachyarrhythmias can also be detected by using implantable subcutaneous cardiac monitors (ICMs) or external loop recorders. The CRYSTAL AF study¹³ was a prospective, multicenter, international, randomized study to determine the incidence of AF among patients randomized to ICM vs standard monitoring. Eligible patients (n=441) were older than 40 years and had a stroke within the last 90 days defined as cryptogenic after to have undergone 12-lead ECG, 24-hour ECG monitoring, transesophageal echocardiography (TEE), computed tomographic angiography or magnetic resonance angiography of the head and neck to rule out an arterial source, and screening for hypercoagulable states in patients younger than 55 years. Standard monitoring was left to the discretion of the attending physician and therefore represents daily practice. AF was detected

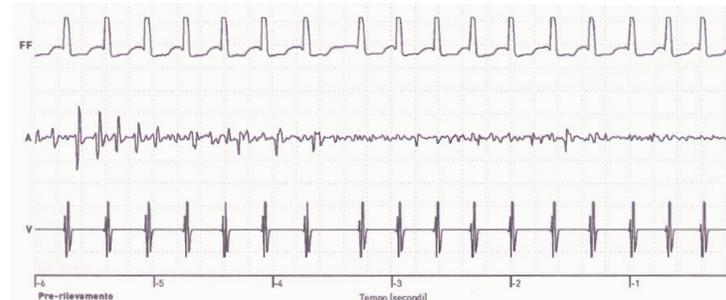


Figure 2 Example of atrial fibrillation detected in a single-lead defibrillator with atrial floating sensing dipole

at a rate of 8.9%, 12.4%, and 30% in the ICM arm and 1.4%, 2%, and 3% in the standard monitoring arm at 6, 12 and 36 months, respectively. At 12 months, the median time from randomization to AF detection in the ICM arm was 84 days, and 79% of these episodes were asymptomatic. More than 92% of patients in the ICM arm with AF detected at 12 months had a day with >6 minutes of AF, a threshold found in the ASSERT study to confer an increased risk of subsequent ischemic stroke. At 36 months, AF was detected at a rate of 30% among ICM patients compared to 3% among control patients (HR 8.8, $P < 0.001$). Oral anticoagulant therapy (OAC) was prescribed for 96.6% of ICM patients in whom AF was detected, by suggesting that physicians found the amount of AF detected clinically relevant. This study demonstrates that long-term continuous monitoring with an ICM is significantly more effective than standard arrhythmia monitoring for the identification of subclinical AF in patients who suffered a cryptogenic stroke.

Similar findings could be demonstrated by using an external loop recorder. The recent EMBRACE study¹⁴ randomly assigned 572 patients (age ≥ 55 years) with cryptogenic stroke to 30-day event triggered external loop recorder vs conventional 24-hour Holter monitoring. Unlike CRYSTAL AF, TEE or intracranial vascular imaging was not required as part of the stroke workup. The primary end-point (detection of AF ≥ 30 seconds within 90 days) was met in 16.1% and 3.2% of patients in the event recorder and control arms, respectively. The secondary end-point (detection of AF ≥ 2.5 minutes within 90 days) was met in 9.9% and 2.5% of patients in the event recorder and control arms, respectively. OAC was prescribed in 18.6% of patients in the event recorder arm vs 11.1% of patients in the control arm, presumably because of the higher rates of AF detection. Compliance with the protocol in the intervention arm was reasonably high at 82% completing ≥ 3 weeks of monitoring, which may not be easily replicated in clinical practice. This study demonstrated that 30-day event-triggered recorder was significantly more effective than conventional 24-hour Holter monitoring for identification of AF in patients who suffered a cryptogenic stroke. Prolonged monitoring nearly doubled the proportion of patients who subsequently received anticoagulant therapy for secondary prevention of stroke. At 90-days follow up 87% of patients with AF episodes in the study group were receiving OAC. This finding is a clinically meaningful change in treatment that has the potential to avoid recurrent strokes. The common practice of relying on 24 to 48 hours monitoring for AF after either a stroke or a TIA of undetermined cause is insufficient and should be considered only as an initial screening.

Oral Anticoagulation for Device-Detected Atrial Tachyarrhythmias

The benefits of OAC in patients with AF/AT are clear, leading to a substantial reduction of not only stroke risk, but also of stroke severity and mortality.⁸ Underused of OAC in AF patients is a well described phenomenon with multiple causes and multifaceted aspects in a general AF population. The increasing prevalence of patients with CIEDs in combination with AHREs and their associated increased risk of stroke/embolism pose new clinical challenges to clinicians.^{9,10,11,12} At present the management of patients with device-detected AF/AT remains controversial, and uncertainties exist about the duration of the longest episode, the cumulative duration and the individual stroke risk.⁸ To date the only prospective randomized trial to address this question was the IMPACT study,¹⁵ which was stopped early and

was unable to demonstrate that daily remote monitoring for ATs with a predefined plan for anticoagulation is superior to a conventional strategy for identification of patients deserving OAC.¹⁶ The incidence of AF/AT detected by PMs or ICDs can reach 50% but only <25% of these patients are treated with OAC.⁸ On the other side, and inexplicably, when AF is detected with an ICM or an external loop recorder (like in CRYSTAL and EMBRACE) many more patients are anticoagulated.^{13,14} There are several potential explanations for this trend. First of all, although Guidelines recognize the role of cardiac devices in detecting AHREs (a surrogate for AF/AT), there is no specific recommendation regarding their use for diagnosis and management in these patients.^{1,6} Few evidences exist about a critical threshold for duration/number of AHRE burden, even if many short episodes could result in the same AF burden as single long-lasting episode.⁸ Moreover while the net clinical benefit of antithrombotic treatment is well established in patients with “clinical” atrial fibrillation, there may be a lower benefit in patients with device-detected AF/AT: in patients with CHADS2 score >2 , the annualized thromboembolic event rate associated with subclinical AHREs was 2.4% in TRENDS and 2.1% in ASSERT,^{9,10} far below from the 4–4.5% annual rate expected in “clinical” AF patients with similar risk profile. So patients with device-detected AHREs (although having a higher risk compared to patients without AHREs) appear to be at lower risk for stroke compared to a “general” AF population: as a result the net clinical benefit of OAC may be reduced.¹⁷ Another issue to consider is the lack of a temporal relationship between subclinical AF and stroke in studies of patients with CIEDs: in ASSERT study 73% of patients with thromboembolism did not show a temporal relationship between AHRE and embolic events.^{8,10} Given the lack of temporal association between device-detected ATs and stroke, a clinician could consider AF only as a marker of stroke risk rather than the proximate cause; so monitoring atrial activity with a CIED could promote a “wait-and-see” approach.

Even if the overall stroke rate in patients with AHREs appears to be less than that in clinically recognized AF, it is crucial to identify a certain high-risk population who deserve anticoagulation, provided that embolic risk exceeds the risk of serious bleeding. By combining AF/AT burden with CHADS2 or CHA2DS2-VASC score and HAS-BLED score we can individualize OAC for appropriate patients at high risk for stroke.¹² It has been suggested that with a CHADS2 or CHA2DS2-VASC score of 1–2 the anticoagulation could be appropriate if a single AHRE episode exceeds 24 hours; with a score >2 the anticoagulation could be started for AHRE lasting > 6 minutes (the higher is the score the shorter is the AHRE duration threshold to start OAC).^{12,17}

CIEDs and ATs Detection: Potentials, Technical Issues, Pitfalls, Clinical Implications

CIEDs are sensitive and specific for diagnosis of AF/ATs. The presence of an implanted atrial lead allows a continuous monitoring of atrial activity and the recording of the episodes in which the sensed atrial rate exceeds a predefined cutoff or deviates from a running average.¹⁷ However, when a CIED is used for the detection of atrial arrhythmias all cardiac rhythm recordings must be adjudicated and reviewed by a qualified clinician to verify their diagnostic accuracy.⁸ There are some factors that limit the diagnostic performance of a CIED: oversensing, undersensing, far-field sensing, cross talk, interference, inappropriate programmed detection

Table 1: Methods for cardiac rhythm monitoring

	PRO	CONS
NON INVASIVE		
Hospital Telemetry	Accurate, also for asymptomatic events	Only hospitalized patients
Holter ECG	Easy to use, continuous recording, also for asymptomatic events	Short monitoring
Event Recorder	Longer monitoring Rhythm-symptoms correlation	Not for asymptomatic events Requires patient's trigger
INVASIVE		
Implantable Loop Recorder	Long periods of monitoring Remote monitoring Asymptomatic events	Expensive and invasive False negative and positive Does not offer therapy
Pacemakers and Defibrillators	Asymptomatic events Also therapeutic	Only if therapeutic indication Expensive and invasive Complications

criteria, differences between manufacturers in diagnostic algorithms for AHRE detection.^{18,19} Moreover the ATs detection rate and the duration of the post-ventricular atrial blanking interval can influence the number of automatic mode-switching episodes.⁸ The storing of electrograms (EGM) in the device memory improved the diagnostic accuracy by allowing to detect and document appropriate versus inappropriate sensing or detections. Several studies showed that the data retrieved from diagnostic counters may sometimes be misleading and, although AHRE are used as a surrogate for AF, the data must be interpreted with caution.^{8,18,19} For example in the ASSERT study 17% of AHREs (>190 bpm lasting >6 minutes) were found to be false positives because of atrial oversensing, runs of premature atrial complexes, far-field R wave detection, repetitive non-re-entrant ventriculoatrial synchrony (RNRVAS). RNRVAS, in particular, was the single most common cause of false positive detection in the ASSERT study; it is triggered by a retrograde ventriculoatrial conduction with functional atrial undersensing and results from retrograde atrial activation during the post-ventricular atrial refractory period and functional atrial non-capture due to stimulation during the absolute refractory period, with the potential to trigger inappropriate mode switching (fig. 1).⁸ On the other hand false AF negatives have been observed when episodes were very brief or atrial sensing was unreliable.^{8,17,18,19}

The need to insert an atrial electrode to detect ATs carries in itself a significant associated risk for complications and higher costs²⁰ which could be solved by using an atrial floating VDD lead if there is no need of atrial pacing. However, an acknowledged issue with VDD system is the dissatisfaction and the instability of the atrial sensing amplitude over time.²¹ This may easily cause underestimation of atrial arrhythmic burden and the loss of synchronized ventricular pacing. Recently a single-lead ICD with atrial sensor (DX ICD Biotronik SE & Co. KG, Berlin, Germany), has been developed in order to maintain the crucial atrial information without implanting an atrial lead. The DX ICD system relies on an atrial floating dipole with enhanced sensing capabilities and has demonstrated to provide reliable atrial sensing in the medium to long term (fig. 2).²²

Regarding ICMs, three new devices with dedicated AF algorithms are on the market (Medtronic Reveal XT, model 9529, Medtronic Inc., Minneapolis, Minnesota; SJM Confirm ICM model DM2102, St Jude Medical Inc., Sunnyvale California and Biotronik BioMonitor, Biotronik SE & Co. KG, Berlin). The Medtronic Reveal XT reported to have an overall accuracy of 98.5% in AF detection.²³

These monitors usually detect AF by analyzing the irregularity and the incoherence of successive R-R intervals with high sensitivity and good specificity.²⁴ However also ICM are affected by to false AF detection due to oversensing or missed AF due to undersensing: so clinical evaluation of recorded episode is always fundamental.

Early Detection Of Atrial Arrhythmias With Daily Remote Monitoring

It is now clear that diagnostics of last-generation devices allow us to have a detailed and complete monitoring of the atrial arrhythmic episodes. These data become meaningful if they are early available for the physician to prevent arrhythmia-related severe adverse events.²⁵ Without remote monitoring any information is available only during in-hospital follow-up, usually scheduled every 6 or 12 months. This represents a great limitation, mainly for asymptomatic patients and for those with mild symptoms. The main potential advantage of daily remote control application in AF management is represented by early detection and early reaction to the arrhythmia occurrence.²⁶ A pilot Italian single-centre study involving 166 patients (73% pacemakers; Biotronik Home Monitoring [HM] system) demonstrated that 20% of patients had alerts for AF. The median reaction time to AF was reduced of 148 days compared with scheduled follow-up.²⁷ The HM-guided unscheduled follow-ups led to clinically significant reactions to AF such as antiarrhythmic drug therapy introduction or modification (48%), anticoagulation starting (45%), or external cardioversion (21%).

In the TRUST trial, (ICDs; Biotronik HM system), AF detection was 34.5 days earlier with remote monitoring vs standard follow-up (5.5 vs 40 days).²⁸

In the CONNECT trial (ICDs; Medtronic CareLink system) the interval between an AF event longer than 12 h and the clinical reaction was eight times shorter with remote monitoring when compared with standard follow-up (3 vs 24 days).²⁹

In the COMPAS trial (PMs; Biotronik HM system), although the study was not powered to make these comparisons, significant differences were observed between the two study groups (remote monitoring vs standard in-hospital follow-up) in the rates of hospitalizations for the management of atrial arrhythmias and strokes.³⁰ Several follow-ups prompted by remote monitoring, which enabled the early detection and management of atrial arrhythmias in the active group, may have prevented the development of more serious adverse events.

The potential benefit of remote continuous monitoring on 2-year incidence of stroke was modeled by running repeated Monte Carlo simulations based on a real population of 166 patients prospectively followed daily.³¹ The results suggested that daily monitoring may reduce the 2-year stroke risk by 9 to 18% with an absolute reduction of 0.2 to 0.6%, compared with conventional inter-visit intervals of 6–12 months. Although this result was derived from a clinical experience performed using a particular paradigm for remote control (Biotronik HM system), it may apply to any remote monitoring system, provided that this is based on wireless automatic daily transmissions with immediate (within 24 hours) notification of AF episodes.

However, the clinical evidence for stroke risk reduction by remote monitoring is still awaited. As outlined before, the prospective randomized IMPACT trial¹⁵ was stopped early. The study hypothesis was that daily remote monitoring for ATs with a predefined plan for

anticoagulation would have been proved superior to a conventional strategy for the identification of patients deserving OAC. 2718 patients, with a dual-chamber or biventricular ICD, were enrolled and randomized 1:1 to either office visits or remote monitoring for AHRE detection (>200 bpm for 36 of 48 beats). When ATs were detected an anticoagulation prespecified protocol was started in the intervention group on the basis of CHADS2 score. Discontinuation of OAC was contemplated for patients without ATs recurrences over time and with low CHADS2 scores. Previous stroke, transient ischemic attack, systemic embolism and clinically documented atrial arrhythmias were Exclusion criteria. No significant differences existed in baseline demographics between the 2 groups. The incidence of ATs was similar for the 2 groups (33% control, 36% interventional group). The adjudication of device-based atrial EGM verified 60.5% of events as AF, 30% as atrial flutter, 9.5% as false positive episodes (with no significant differences between the 2 groups). After 5 years follow-up the Data Monitoring Committee recommended the trial termination, because of the failure to demonstrate any significant differences in the outcome between the two groups. No statistically significant difference was found in the primary outcome, which was a composite of ischemic stroke, systemic embolism, major bleeding and all-cause mortality. However, in the interventional group the OAC was started earlier (3 vs 54 days; $p < 0.001$) by indicating that remote monitoring facilitated earlier reactions for ATs.¹⁶ No clear explanations for these results are available; the compliance with the OAC in the interventional group was suboptimal, but the overall primary event rate was low nevertheless. Moreover, like in the previous studies^{8, 10} no temporal relationship was found between device-detected ATs and thromboembolic events. The investigators concluded that the beginning and the discontinuation of the anticoagulation therapy based on the presence of device-detected ATs available from the home monitoring did not improve clinical outcome in this specific population.⁸

The first experiences of AF home monitoring with ICMs have been carried out showing promising results.^{32, 33} A single center pilot study involving 186 patients suffering of AF and implanted with ICM equipped with daily remote monitoring (Biotronik HM system) demonstrated that 26% of the patients had a clinical interventions triggered by remote transmissions with a mean follow up of 6 months. All the clinical interventions were performed within 24 hours after the remote alert. The main frequent reaction was a therapy change.³³

The Organization Model for Remote Monitoring of AF Patients

The HomeGuide Registry (Biotronik HM system) is a large registry which investigated the impact of remote monitoring of CIEDs on the patient management in daily practice.³⁴ The main result of the study showed that, by applying a structured organizational model, remote monitoring of CIEDs may be effectively introduced in standard clinical practice combining high effectiveness in clinical and device-related cardiovascular events detection, with a very low manpower and resource consumption. This is crucial for AF management, where early reaction from the remote notification is fundamental. The HomeGuide model is essentially based on a cooperative interaction between the roles of an expert reference nurse and a responsible physician, with an agreed list of respective tasks and responsibilities. Home Monitoring transmissions were reviewed by the nurse within

two working days. In the case of critical alerts, such as AF episode detected, the responsible physician was contacted for the clinical decision.

The HomeGuide Registry showed that the applied organizational model may lead to an overall manpower for remote follow-ups which is less than one hour/month every 100 patients.³⁵ Such result was obtained in centers with different activity volumes recruited in different regions of Italy, by underlining the success of the applied workflow model and the used technology.

Conclusions

Patients with CIEDs represent a special population with multiple comorbidities predisposing to atrial arrhythmias, especially AF, which are often paroxysmal, intermittent and asymptomatic. "Subclinical" atrial tachyarrhythmias are associated with a significant increase in the risk of stroke and systemic embolism and may be unmasked only with more aggressive monitoring techniques. Patients with dual-chamber pacemakers and implantable cardioverter defibrillators, as far as with implantable cardiac monitor, represent a unique opportunity to screen for and unmask silent AF episodes. Until further studies will be carried out, anticoagulation therapy should be individualized according to stroke risk scores in combination with the burden of AF/AT detected by the device. At the meantime, the recently designed ARTESIA study will evaluate if the treatment with Apixaban, compared to aspirin, could reduce the risk of ischemic stroke and systemic thromboembolism in pacemaker patients with subclinical AF and additional risk factors for stroke.³⁵

All these data become meaningful if they are early available and today this is possible thanks to the daily remote monitoring of the devices. The challenges for clinicians are to deal with the huge data entry, to define new organizational models, to improve device patient management and to continuously update AF guidelines according to the great amount of data offered by new technologies. Future AF guidelines should consider this peculiar scenario and, hopefully, make more specific recommendations, in particular regarding anticoagulation therapy.

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