Atrial Fibrillation Monitoring
Mathematics Meets Real Life

Gerhard Hindricks, MD; Christopher Piorkowski, MD

In today’s clinical practice the diagnosis of atrial fibrillation (AF) is made by an ECG documentation that fulfills established criteria. That documentation is of utmost clinical importance because it is the basis for further therapeutic interventions, such as rhythm control strategies or introduction of oral anticoagulation. ECG documentation of AF, however, carries 2 distinct limitations. First, the occurrence is unpredictable in terms of onset and duration of arrhythmia episodes. Second, patient symptoms are of limited value identifying arrhythmia episodes and to subsequently enable successful ECG recordings. As such, multiple studies have described a high prevalence of asymptomatic or silent AF in various patient populations.1–3

Studies have documented the incremental benefit in the rate of AF detection obtained with intensified monitoring efforts. After AF catheter ablation arrhythmia recurrences were documented in 17% versus 45% of the same patient population, depending on follow-up with 24-hour versus 7-day Holter and various modes of transtelephonic monitoring.4

Studies have documented the incremental benefit in the rate of AF detection obtained with intensified monitoring efforts. After AF catheter ablation arrhythmia recurrences were documented in 17% versus 45% of the same patient population, depending on follow-up with 24-hour versus 7-day Holter and various modes of transtelephonic monitoring.4

To better characterize the arrhythmia, to improve outcome assessment after therapeutic interventions, and to optimize individual clinical decisions, methodologies of more and more intense rhythm monitoring have entered clinical and scientific use. Traditionally applied techniques have evolved from rhythm strip, 12-lead ECG, and 24-hour Holter to 7-day Holter and various modes of transtelephonic monitoring.5

Studies have documented the incremental benefit in the rate of AF detection obtained with intensified monitoring efforts. After AF catheter ablation arrhythmia recurrences were documented in 17% versus 45% of the same patient population, depending on follow-up with 24-hour versus 7-day Holter and various modes of transtelephonic monitoring.4

An exact answer can only be expected from data collected during continuous rhythm monitoring approaches. First, such insights were obtained in pacemaker patients. Respectively studies have shown a large amount of asymptomatic undiagnosed AF with significant clinical implications such as thromboembolic risk.6,11 However, the specific patient cohort limits the generalization of these findings to the wider AF population. Enabling continuous AF monitoring also in patients without classical cardiac device indication implantable loop recorders (ILR-AF) with dedicated AF detection algorithms have been introduced recently. Diagnostic accuracy of the initial detection algorithm has been evaluated in the recent trial.12 During 46 hours of monitoring, sensitivity and specificity of AF detection measured 96.1% and 86.4%.12 However, a subsequent clinical study with longer monitoring periods raised some concerns about the algorithm specificity, mainly because of oversensing resulting from muscle potentials and limited electrogram storage capacity of the device.13 Meanwhile, several additional studies on the feasibility of ILR-AFs for continuous AF monitoring have been published.14,15 The studies showed a higher AF detection rate as compared with discontinuous rhythm monitoring, however—as a limitation—the concerns about the algorithm specificity were not always adequately addressed.

In this issue of Circulation, Charitos and colleagues16 present an interesting and valuable comparison of continuous versus discontinuous AF monitoring based on a mathematical model built from patients with either ILR-AF or cardiac pacemakers. The complete rhythm history of the enrolled patients was reconstructed from the device data. Frequency and burden of AF was analyzed. As a novelty, the term AF density as a measure of the temporal distribution of AF episodes was introduced. Data from continuous monitoring were then compared with intermittent monitoring strategies of various durations and frequencies using a computer simulation model. The key findings of the study were (1) longer monitoring results in more AF detection, (2) even with intense intermittent monitoring a significant amount of AF episodes/burden can be missed, and (3) the temporal distribution of AF episodes has a significant impact on the sensitivity of AF detection with intermittent rhythm monitoring.

The authors have to be congratulated for the interesting study. The data present significant mathematical support for the aforementioned limitations observed with discontinuous AF monitoring. It is interesting to note that in this simulation close intermittent monitoring was able to detect up to 70% to 80% of the patients with AF recurrences—a number that has been similarly observed in respective clinical investigations.13 The term AF density is interesting and deserves further consideration in future clinical and scientific discussions. It is especially noteworthy that in patients with low AF density (66% of the entire study population), intermittent monitoring was effective to capture the arrhythmia. In those
patients the serial 24-hour Holters, serial 7-day Holters, and single 30-day Holter resulted in a sensitivity of >80% to 90%, respectively. On the other hand, the largest benefit of continuous AF monitoring was calculated for the minority of patients with high density and low burden AF, a finding that may be relevant after AF catheter ablation.

Despite the interesting data presented by Charitos and colleagues, some open questions remain. The largest deficit in clinical compatibility is the lack of any consideration on patients’ symptoms. Despite all limitations of symptoms in AF patients, there is a certain percentage where AF diagnosis is also guided by symptoms. Thus, the huge benefit in AF detection using continuous monitoring in this study should only be true for a completely asymptomatic patient population (ie, 100% asymptomatic patients over 100% of the monitoring time). This assumption does not reflect clinical reality. Further shortcomings relate to a highly selected cohort with preferentially elderly patients (68±12 years of age), with significant structural heart disease and a substantial number (33%) of patients after cardiac surgery. That is not the patient population typically undergoing rhythm control strategies. In addition, only slightly >10% of the patients had an ILR-AF, whereas almost 90% of the data were taken from cardiac pacemakers that had been implanted mainly because of sinus node dysfunction or advanced AV-block. Thus, significant limitations concerning the generalization of the data to other AF patient populations apply.

Overall, and despite our critical remarks, the authors have to be congratulated for their study. The results clearly show that continuous monitoring substantially increases the AF detection rate. However, before transferring the findings into clinical applications of wider ILR-AF–based rhythm monitoring significant questions remain: Which patients are likely to benefit from continuous monitoring, and what is the benefit? Is it safe to withdraw oral anticoagulation under the guidance of continuous rhythm monitoring? How do implantation costs and implantation complications balance to potential benefits? All this is currently unknown, and future prospective trials are warranted to answer these questions before routine clinical application of ILR-AFs for continuous rhythm monitoring can be recommended. Such studies urgently need to be done, because in AF … knowing is better than guessing.

Disclosures
Dr Hindricks was Principal Investigator of the XPECT Trial12 that evaluated the algorithm of an implantable loop recorder; this study was sponsored by Medtronic. Dr Hindricks is the Principal Investigator on research grants from St. Jude Medical, Biosense Webster, and Biotronik to study innovations in catheter ablation and cardiac implant technology. Dr Hindricks has received lecture fees and consulting fees from St. Jude Medical, Biosense Webster, and Biotronik. Dr Piorkowski is the Principal Investigator on research grants from St. Jude Medical, Bio-sonex Webster, and Biotronik. Dr Hindricks is the Principal Investigator on research grants from St. Jude Medical, Biotronik, Siemens, and Imricor.

References
Atrial Fibrillation Monitoring: Mathematics Meets Real Life
Gerhard Hindricks and Christopher Piorkowski

Circulation. 2012;126:791-792; originally published online July 23, 2012;
doi: 10.1161/CIRCULATIONAHA.112.124735

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/126/7/791

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org/subscriptions/