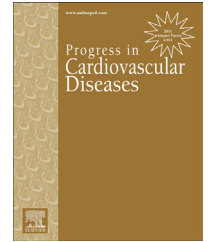


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# Ambulatory ECG Monitoring in Atrial Fibrillation Management

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## ABSTRACT

Ambulatory ECG monitoring technology has rapidly evolved over the last few decades and has been shown to identify life-threatening and non-life threatening arrhythmias and provide actionable data to guide clinical decision making. Atrial fibrillation episodes can often be asymptomatic, even after catheter ablation for atrial fibrillation, creating a disconnect between symptoms and actual arrhythmia burden which may alter clinical management. In this review, we aim to provide a comprehensive overview of invasive and non-invasive ECG monitoring strategies in patients with atrial fibrillation, with a special focus on the diagnosis of atrial fibrillation, and on follow-up of patients after catheter ablation for atrial fibrillation ablation.

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Recent technological advancements have facilitated ambulatory electrocardiogram (ECG) monitoring in the outpatient environment providing continuous, high resolution ECG data streams ranging from days to months at a time. Wireless communication has permitted the transfer of relevant ECG data in real-time encouraging rapid analysis and timely clinical intervention. The rapid commercialization and competitive market for managing patients with atrial fibrillation (AF) have produced a large menu from which clinicians must now carefully choose to meet the needs of their patients.

Atrial fibrillation is the most common arrhythmia, especially in hypertensive patients, in the elderly<sup>1–5</sup> and in those with heart failure (HF).<sup>6–8</sup> The incidence and prevalence of atrial fibrillation are constantly growing.<sup>9</sup> A recent study suggested that the incidence of atrial fibrillation will double

by the year of 2030, and the prevalence of the disease will reach 12.1 million cases in the United States.<sup>10</sup>

Furthermore, AF may have significant clinical consequences. It is known to be associated with a significant increase in the risk of stroke, HF hospitalization and related health care costs.<sup>11</sup> Catheter ablation for atrial fibrillation ablation has become an established method to provide efficient rhythm control in patients with atrial fibrillation and has been claimed as a “cure” for the disease. However, long-term success data are still lacking, and success also depends on the ECG modality that is used to monitor AF episodes.<sup>12</sup>

This review article will provide an overview on the invasive and non-invasive ECG monitoring tools in atrial fibrillation with a focus on atrial fibrillation diagnosis, and follow-up in patients undergoing catheter ablation. Furthermore, we present data on new methods to be investigated in this rapidly evolving field.

Statement of Conflict of Interest: see page 150.

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Abbreviations and Acronyms	
AF	= atrial fibrillation
AT	= atrial tachycardia
CRT	= cardiac resynchronization therapy
ECG	= electrocardiogram
ELEM	= event loop monitoring
HF	= heart failure
ICD	= implantable cardioverter defibrillator
ILR	= implanted loop recorder
MCOT	= mobile cardiac outpatient telemetry
PM	= implanted pacemaker

### General considerations

In patients with atrial fibrillation, initial diagnosis has been most often made utilizing a 12-lead ECG or Holter monitoring. Therapy efficacy has been evaluated by patient-reported symptoms, repeated 12-lead ECG recordings or Holter monitoring. However, several studies suggested that episodes of AF occur without symptoms.<sup>13–15</sup> These events may carry sig-

nificant risk of stroke, and thromboembolic events and falsify the success rate of catheter ablation for atrial fibrillation. Therefore, the identification of AF episodes and recurrences is relevant.

Long-term Holter recording and event monitors were proven to have a superior diagnostic yield compared to 12-lead ECG or 24/48-hour Holter monitoring; however, the complexity of these devices, patient compliance, need of a

transmitter device, and in some cases the relatively slow review of the records limit every-day clinical applicability.

Newer techniques using patch-type monitors that provide real time feedback to the care provider or to the patient itself are more useful in clinical practice and may drive immediate changes in medical therapy or patient care to improve clinical outcome. These new methods need to be not only simple, but reliable, with sufficient capability to store and to transmit episodes.

However, the most optimal devices are those that provide continuous long-term monitoring, 24 hours, 7 days a week, with immediate feedback. Implanted loop recorders (ILR), and implanted pacemakers (PM), defibrillators (ICD), or cardiac resynchronization therapy devices (CRT) are able to do continuous monitoring and produce output of the recorded rhythm abnormalities. However, necessity of the invasive procedure restricts their wide applicability.

The key points in current ambulatory ECG monitoring are 1) long-term monitoring capabilities, 2) instant feedback, 3) simplicity, 4) every-day use, 5) non-invasive nature. A summary of ambulatory ECG monitoring tools with respected ranges of diagnostic accuracy is listed in Fig 1 and discussed in details in the chapters below.

However, the requirements for diagnosing AF and for follow-up of patients after catheter ablation for AF are somewhat different. Suggested schemes for diagnosing AF and evaluating the success rate of catheter ablation are depicted in Figs 2 and 3 and will be discussed later.

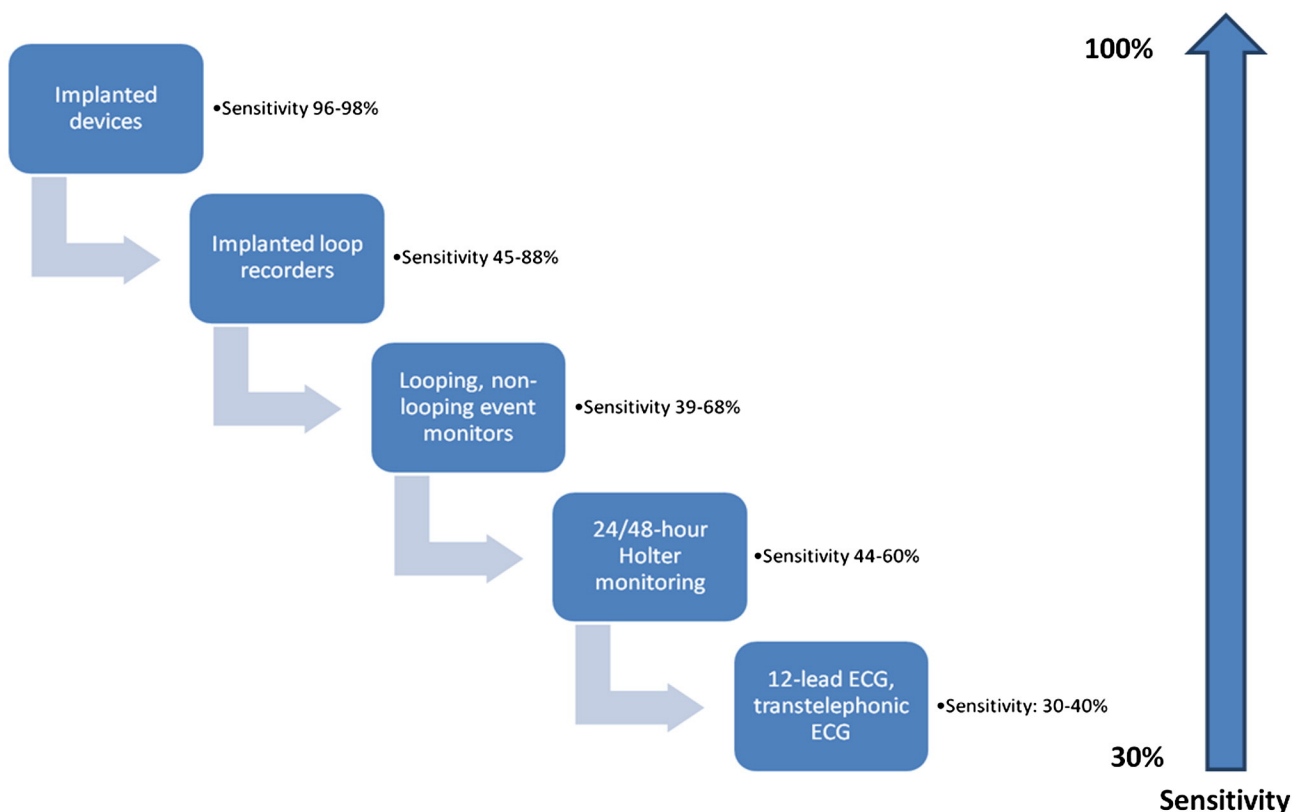


Fig 1 – Summary of ambulatory ECG monitoring tools with respected ranges of diagnostic accuracy.

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