Technical Information Report

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Signal averaging

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Abstract: The signal-averaged electrocardiogram (SAECG) facilitates noninvasive recording of low-amplitude cardiac signals such as ventricular late potentials. The SAECG has been used to predict life-threatening ventricular tachyarrhythmias in patients after acute myocardial infarction and with nonischemic dilated cardiomyopathy and to screen for inducible ventricular tachycardia in patients with unexplained syncope and with nonsustained ventricular tachycardia. This technical information report focuses on currently accepted methodology and clinical applications of the SAECG.

Key words: signal-averaged electrocardiogram (ECG), ventricular tachycardia, sudden cardiac death, electrophysiologic study, syncope, myocardial infarction, cardiomyopathy, atrial fibrillation

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Standards and recommended practices are subject to a formal process of committee approval, public review, and resolution of all comments. This process of consensus is supervised by the AAMI Standards Board and, in the case of American National Standards, the American National Standards Institute.

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Committee representation

Association for the Advancement of Medical Instrumentation
Electrocardiograph Committee

This technical information report (TIR) was developed by the ECG/Signal Averaging Working Group of the AAMI Electrocardiograph Committee. Committee approval of the TIR does not necessarily imply that all committee members voted for its approval.

At the time this document was balloted, the **AAMI Electrocardiograph Committee** had the following members:

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NOTE—Participation by federal agency representatives in the development of this report does not constitute endorsement by the federal government or any of its agencies.

Signal averaging

1 Scope

Signal averaging of the electrocardiogram (SAECG) was devised 25 years ago to reveal low-amplitude cardiac signals in the microvolt range on the body surface. It was originally used to detect His-Purkinje activity (A.1). However, in the next decade the methods for SAECG were refined and developed to determine the full extent of ventricular activation with the object of revealing delays relating to electrical instability of the ventricular myocardium.

The purpose of this report is to provide an understanding of the fundamental principles underlying SAECG methodology, to define terminology, and to review its potential for clinical application. It includes a discussion of some of the major pitfalls that must be avoided. This report is directed partly to those who have an interest in the clinical use of the SAECG but also to those who are considering the development of SAECG methodology in a medical device. The following topics are covered:

a) device architecture for data acquisition and processing;
b) beat selection and alignment;
c) ensemble averaging;
d) filtering, lead combination, and measurement;
e) clinical applications and emerging uses;
f) a list of publications for further reference;
g) terminology.

2 Definitions

For the purposes of this technical information report, the following definitions apply.

2.1 bandpass filter: A filter that will pass frequencies within a desired range but will attenuate all other frequencies (e.g., a 40– to 250–Hz filter would attenuate frequencies below 40 Hz and above 250 Hz).

2.2 baud rate: The number of bits per second that can be transmitted in a given computer system.

NOTE—When information is transmitted between two computer systems, each must be set to the same baud rate.

2.3 bidirectional filter: A type of digital filter that filters the signal in a forward direction from its beginning to its midpoint and then filters from the end of the signal in a backward direction to the same midpoint.

2.4 Butterworth amplitude filter: A type of filter known for its filter quality on small signals; the filter of choice for the vector magnitude and late potential detection.

2.5 corner frequency: The frequency or frequencies selected to define a filter band (e.g., 40– to 250–Hz Butterworth filter).

2.6 FFT: Fast Fourier Transform is a method by which a segment of time series data can be evaluated for its frequency components.

2.7 fiducial point: A reliable, stable reference point that allows multiple beats to be aligned for averaging.

NOTE—One fiducial point commonly used for SAECGs is the onset of the QRS or the time of maximum slope of the QRS.

2.8 filter: A device or software algorithm that passes information within signals of certain frequencies or frequency ranges while attenuating others.

2.9 finite impulse response (FIR) filter: A type of filter that relies only on previous input to generate its present output.

2.10 high pass filter: A filter that attenuates frequencies below a specified frequency (e.g., a 40–Hz high pass filter would attenuate all frequencies below 40 Hz).