Recommendations of the Brazilian Society of Cardiac Arrhythmias for Holter Monitoring Services

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Abstract

Background: There are innumerous indicators to assure the quality of a service. However, medical competence and the proper performance of a procedure determine its final quality. The Brazilian Society of Cardiac Arrhythmias recommends minimum parameters necessary to guarantee the excellence of ambulatory electrocardiographic monitoring services.

Objective: To recommend minimum medical competences and the information required to issue a Holter monitoring report.

Methods: This study was grounded in the concept of evidence-based medicine and, when evidence was not available, the opinion of a writing committee was used to formulate the recommendation. That committee consisted of professionals with experience on the difficulties of the method and management in providing services in that area.

Results: The professional responsible for the Holter monitoring analysis should know cardiovascular pathologies and have consistent formation on electrocardiography, including cardiac arrhythmias and their differential diagnoses. The report should be written in a clear and objective way. The minimum parameters that comprise a Holter report should include statistics of the exam, as well as quantification and analysis of the rhythm disorders observed during monitoring.

Conclusion: Ambulatory electrocardiographic monitoring should be performed by professionals knowledgeable about electrocardiographic analysis, whose report should comprise the minimum parameters mentioned in this document. (Arq Bras Cardiol. 2013;101(2):101-105)

Keywords: Arrhythmias, Cardiac / diagnosis; Electrocardiography, Evidence-Based Mediate Ambulatory.

Introduction

Ambulatory electrocardiographic monitoring, simply named Holter or 24-hour Holter, is a non-invasive method widely used to assess electrocardiographic abnormalities of patients with various cardiac or non-cardiac diseases, as well as healthy individuals under special conditions or situations. Developed in the 1960s, it underwent great technological advance in recent years. Currently, the recording and storing system used (Holter recorder) is digital, having usually three channels. The device is small (approximately 8.5 x 5.3 x 2.0 cm) and lightweight (45 to 90 grams), being powered by battery, either alkaline or regular. Additional protection against fluid immersion is recommended. Recording is performed with three-channel bipolar electrodes (leads). To mark events, the recorder should have a button, which can be activated by the patient under special conditions, such as the presence of a symptom.

Since the 1980s, with the evolution of electronic storage, those devices evolved from real-time analysis to storage of digitalized data. Such conditions allowed a large increment in recording reliability, minimizing not only the distortions that can occur in tape recordings, but also the imperfections generated by the mechanical factors inherent in the mechanisms responsible for the rotation of the system. Data analysis has gained in accuracy and details. The 200-Hz frequencies are adequate for the analysis of ST-segment deviations and rhythm disorders. To obtain signal-averaged ECG, 1000-Hz frequencies are required.

Recently, digital recorders were made available with the option of 12-lead data acquisition, by use of a cable with either ten electrodes or only five electrodes when the orthogonal leads (X, Y, and Z) of vectocardiography are associated. The software generates the electrocardiographic recording with the conventional 12 leads, at any point of the analysis.

A good quality electrocardiographic recording is fundamental to the usefulness and reliability of the examination proposed, providing the necessary information. When that quality decreases, the amount of information also decreases, while the time for necessary edition increases enormously.

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Clinical application and types of ambulatory electrocardiographic monitoring

Typically, ambulatory electrocardiographic monitoring is classified according to the monitoring category into continuous and intermittent recordings. Continuous recordings usually occur for 24 hours to 48 hours, while intermittent recordings occur for longer periods of time. The device for intermittent recording, named event recorder, has a memory loop that saves random recordings or those motivated by any clinical symptom. Although there is no clinical study assessing the profile of patients who better benefit from continuous or intermittent recordings, the frequency of the symptoms is the parameter used to choose between both methods. Thus, for patients with sporadic symptoms, the use of the event recorder might be more appropriate, especially for assessing near syncope, syncope and sporadic palpitations[1].

The implantable event recorder is available in the market to document infrequent symptoms. It is a small device implanted under the skin of the infraclavicular region, which can maintain circular electrocardiographic monitoring for long periods.

The use of digital 3-channel 24-hour Holter in clinical practice is aimed at characterizing and diagnosing the occurrence of abnormal electrical cardiac behavior during daily activities (sleep, work, physical exercise, emotional stress, rest). It is mainly, but not exclusively, used for symptomatic or asymptomatic cardiac arrhythmias. However, Holter analysis can also provide the following: ST-segment assessment with or without associated arrhythmias (such as intermittent preexcitation, Brugada-type abnormalities, silent or non-silent ischemia, short or long QT, transient or non-transient abnormality); and autonomous nervous system analysis via heart rate variability[2]. In addition to diagnostic assessment, Holter monitoring can be used to evaluate the efficacy of therapy, both pharmacologic and invasive, for cardiac rhythm disorders and to stratify the risk for sudden death (Box 1).

Box 1 - Analyses available on ambulatory electrocardiographic monitoring

I – Assessment of symptoms that might be related to cardiac rhythm disorders

II - Assessment of myocardial ischemia

III - Assessment of the risk for future cardiac events
- cardiac arrhythmia
- heart rate variability
- myocardial ischemia
- microvolt T-wave *alternans* (TWA)
- QT-interval variations

IV – Therapeutic assessment
- drugs
- surgery
- catheter ablation
- implantable pacemakers and defibrillators

V – Special situations
- atrial fibrillation
- syncope

VI – Assessment of pacemaker

The pattern of beat-to-beat heart rate variability, at baseline or in response to a certain standardized stimulus, can be an objective and non-invasive measure to quantify the autonomic status under physiological and pathological conditions[3]. The analysis techniques most frequently used to determine heart rate variability are obtained in the time and frequency domains.

Measures in the time domain are usually taken during 24 hours. In such recordings, the QRS complexes are detected, artifacts and ectopic beats being excluded to avoid hindering statistical analyses. The frequency cycles between the QRS complexes are determined and the statistical distributions of all cycles are calculated as mean and standard deviation. The frequency domain analyzes heart rate variability in another way, its principle residing in the fact that every NN interval can be broken into a series of oscillatory components with different frequencies and amplitudes.

Box 2 shows the major cardiac arrhythmias that can be diagnosed by use of digital 3-channel 24-hour Holter.

Technical aspects of the method

Although electrode placement may seem to have little significance for Holter monitoring, it is fundamental to a successful procedure. The skin should be properly cleansed with alcohol to remove grease, and then dried before placing the electrodes, which should be pressed in the periphery of their adhesive areas, and not in their centers, to avoid displacing the gel. A good quality electrode is cost-effective, because it guarantees a better tracing quality and less skin irritation. Box 3 shows the technical recommendations for 24-h Holter monitoring.

Holter should be performed with at least three bipolar channels. If on the one hand an increase in the number of electrodes increases patient's discomfort, on the other, the origin of some arrhythmias can be located with a greater number of leads. Although the cases should be individually considered, in clinical practice, the use of three leads seems to meet the requirement in most situations.

The choice of the leads should be standardized to allow maximum information regarding morphology and should have good amplitude to avoid failure in heart beat capture. The electrocardiographic channels usually used in Holter monitoring are the modified bipolar leads: V5, V3 and inferior lead[4].

The recommended maximum density of artifacts during monitoring is 5%. Greater figures should be analyzed considering the need to repeat the recording. In some cases with spiked T wave, it can be misdetected as a beat, and thus the complex needs to be excluded, causing an overestimated artifact rate that does not interfere with the overall analysis.

Day-to-day variability in the distribution of arrhythmias is a reality[5-7]. Most clinical studies on arrhythmias uses 24-hour monitoring; however, more prolonged periods or repetition of the monitoring can increase the accuracy of the exam[8]. The Brazilian Society of Cardiac Arrhythmias recommends monitoring for at least 18 hours, including wakefulness and asleep periods, for the analysis and report of ambulatory electrocardiographic monitoring.

Box 2 - Major diagnoses provided by use of digital 3-channel 24-hour Holter

Sinus rhythm and arrhythmias Sinus rhythm Sinus tachycardia (>100 bpm) Sinus bradycardia (<50 bpm when awake; < 40 bpm when asleep) Sinus arrhythmia Sinus arrest or pause Sinoatrial block **Other supraventricular rhythms** Premature atrial contraction Non-conducted premature atrial contraction Premature atrial contraction rhythm Ectopic unifocal atrial tachycardia Multifocal ectopic atrial tachycardia Atrial fibrillation Atrial flutter Premature junctional complexes Junctional escape complexes or rhythm Accelerated junctional rhythm Automatic junctional tachycardia Supraventricular paroxysmal tachycardia **Ventricular arrhythmias** Premature ventricular contraction Skipped beat heart rhythm Accelerated idioventricular rhythm Ventricular tachycardia Polymorphic ventricular tachycardia (including *torsade de pointes*) Ventricular fibrillation **AV conduction** First-degree AV block Type 1 second-degree AV block (Mobitz 1 / Wenckebach) Type 2 second-degree AV block (Mobitz II)	2:1 AV block or conduction AV block with variable conduction Advanced AV block (high grade) Complete AV block (third degree) AV dissociation **Intraventricular conduction** Left bundle-branch block (fixed or intermittent) Right bundle-branch block (fixed or intermittent, complete or final delay in conduction)_Unspecific delay in intraventricular conduction Supraventricular beats with aberrant conduction Ventricular preexcitation (Wolff-Parkinson-White pattern) **Changes in ventricular repolarization (ST-T, U)** Early repolarization (variant of normal) Juvenile T waves (variant of normal) Unspecific ST-segment and/or T-wave abnormalities ST and/or T wave suggestive of ischemia Prolonged QT interval Prominent U waves **Cardiac pacemaker** Atrial paced rhythm Ventricular paced rhythm Atrial sensed and ventricular paced rhythm AV dual paced rhythm Failure of atrial capture Failure of ventricular capture Failure of atrial inhibition Failure of ventricular inhibition Failure to trigger the pacemaker (malfunction) Retrograde atrial activation Pacemaker-mediated tachycardia

bpm: beats per minute; AV: atrioventricular

Minimum knowledge and training required to analyze electrocardiographic monitoring tracings

The professional responsible for analyzing the Holter monitoring, in addition to knowing cardiovascular pathologies, should have a consistent and specific formation in electrocardiography, including cardiac arrhythmias and their differential diagnoses. The correct interpretation of ST-segment deviations, cardiac ischemia and heart rate variability also constitutes a necessary attribute for issuing a Holter report. Box 4 summarizes the major points of medical knowledge required to assess ambulatory electrocardiographic monitoring.

Proof of competence

Assessing and interpreting the ambulatory electrocardiographic tracing is a medical act to be performed exclusively by physicians registered in the Regional Board of Medicine, who are apt to professional practice. The Brazilian Society of Cardiac Arrhythmias (Sobrac) recommends that professionals have the specialist title in clinical arrhythmia or electrophysiology with a minimum supervised experience of analyzing 150 tracings[9], in addition to competence regarding the necessary medical knowledge listed in Box 4.

Role of the Holter technician

The performance of a Holter technician at a certain service depends on the preference of the physician in charge. Box 5 lists the technician's assignments. It is worth noting that the technician is forbidden to act alone without the supervision of a knowledgeable physician according to the recommendations of Box 4.

The Holter technician should be trained at official institutions or with an acknowledged professional in the field with a minimum experience of analyzing 1,000 tracings.

Minimum report in ambulatory electrocardiographic monitoring

The report should be written in a clear and objective way. The report digital file should be saved for at least five years, preferentially for ten years. The report should comprise the parameters listed in Box 6.

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Box 3 - Technical recommendation for ambulatory electrocardiographic monitoring

- Skin cleansing
- Good quality electrodes
- Proper positioning of electrodes (bipolar V1, V3 and V5)
- Use of digital recorders
- Minimum 18-h recording including wakefulness and asleep periods
- Minimum of 3 channels
- Maximum of 5% of artifacts

Box 4 - Summary of the knowledge required to assess ambulatory electrocardiographic monitoring

• To know the proper indications for ambulatory electrocardiographic monitoring.
• To know cardiac arrhythmias, their diagnoses and meaning in healthy individuals and cardiac patients.
• To know the wide variability of arrhythmias that can occur in ambulatory patients during a day cycle and the influence of the autonomous nervous system on cardiac rhythm.
• To know the electrocardiographic changes that can result from exercises, hyperventilation, conduction disorders, electrolytic changes, drugs, food, temperature, Valsalva's maneuver, sympathetic and vagal influence, respiratory disorders of sleep, position variation, ischemia, and transient phenomena of repolarization related to a variety of cardiac diseases and their treatment.
• To know the drugs used in cardiology and how they can affect conduction and repolarization on the electrocardiogram, particularly in suspected proarrhythmia phenomena.
• To know the diagnostic sensitivity, specificity and accuracy of ambulatory electrocardiography in several age and population groups, particularly regarding changes in the ST segment, and the application of Bayes theorem.
• To know the ST-segment deviations most accepted as criteria for ischemia.
• To identify on ambulatory electrocardiogram the evidence of loss of capture, loss of sensing, and loss of pacing of pacemakers and cardioverter/defibrillators.
• To identify on ambulatory electrocardiogram the evidence to diagnose appropriate or inappropriate therapy with antitachycardia stimulation or defibrillation in patients with implantable cardiac defibrillator.
• To have basic understanding of the advantages and disadvantages of the equipment used for continuous and intermittent ambulatory electrocardiography recording and the possible causes of false-positivity and false-negativity of tests due to limitations inherent in the equipment or in signal processing.
• To know the particularities of the ambulatory electrocardiographic monitoring equipment.
• To appreciate the competences required for the technician to interact with the ambulatory electrocardiographic monitoring equipment in the final computer edition and the need to have that technician's competence assured.

Box 5 - Attributions of the Holter technician at ambulatory electrocardiographic monitoring services

- Import and export of tracings in computerized systems
- Diagnostic assessment and elimination of artifacts
- Selection of significant tracings for the Holter report
- Selection of symptom-related tracings

Box 6 - Minimum requirements for issuing a report in ambulatory electrocardiographic monitoring

• Baseline cardiac rhythm during monitoring with mean, minimum and maximum heart rate.
• To quantify and qualify the rhythm disorders of atrial origin.
• To quantify and qualify the rhythm disorders of ventricular origin.
• To assess the presence of pauses and to quantify their duration and relationship with wakefulness and asleep periods.
• To assess the presence and type of AV conduction disorders.
• To assess the presence and type of IV conduction disorders.
• To assess the presence of ventricular repolarization disorders, such as QT-interval duration.
• To assess the Holter diary and correlate symptoms with concomitant electrocardiographic findings.
• To assess the medications used in the 24-hour period and correlate them with electrocardiographic findings.
• To report the technical quality of the recording when applicable.
• To provide a statistical summary of events.
• To provide a timetable with heart rate behavior and distribution of arrhythmic events.
• To provide a graph with the ST-T segment behavior in the presence of a change.
• To provide an electrocardiographic recording of the major events identified at the speed of 25 mm/s and gain of 1 mm/mVolt.
• To provide an electrocardiographic recording at the beginning and end, at the speed of 25 mm/s and gain of 1 mm/mVolt.
• To provide an electrocardiographic recording of the maximum and minimum heart rate at the speed of 25 mm/s and gain of 1 mm/mVolt.
• To provide condensed recordings that can be used to exemplify more prolonged arrhythmias or their occurrence in a wider context.
• To provide the electrocardiographic tracings that validate the findings described in the report.
• To provide a summary of heart rate variability when applicable.
• To record at least 8 tracings per exam.
• To provide readable name, signature and inscription number in the Regional Board of Medicine of the physician in charge. To provide a digital signature for reports sent over the internet.

Note: AV: atrioventricular. IV: interventricular.

Author contributions

Conception and design of the research: Lorga Filho A, Lorga A; Acquisition of data: Lorga Filho A, Cintra FD; Analysis and interpretation of the data: Cintra FD; Writing of the manuscript: Cintra FD, Grupi C, Pinho C, Moreira D, Sobral Filho DC, Brito FS, Krusi JCL, Sobral Neto J; Critical revision of the manuscript for intellectual content: Lorga Filho A, Cintra FD, Lorga A, Grupi C, Pinho C, Moreira D, Sobral Filho DC, Brito FS, Krusi JCL, Sobral Neto J.

Potential Conflict of Interest

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