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ECG Holter

Guide to Electrocardiographic Interpretation

Foreword I by Prof. Lukas Kappenberger
Foreword II by Prof. Philippe Coumel

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To Maureen and Kilian

Foreword I

For centuries the analysis of the heart rhythm has belonged to the foundations of medical art. We know that doctors in ancient Tibet used the interpretation of the heart rate to draw prognostic conclusions—somehow a modern rationale—that deserves further attention.

The rapid advancement of science is providing more and more information about the details, but the subatomic resolution of structures hides the risk and the complex procedures are fragmented into static impressions. The same has happened to the ECG. The revolutionary development, acknowledged by the Nobel Prize for Einthoven, led from the analysis of the dynamic heart rate to the static analysis of the heartstream curve. It is only with the ECG Holter recording over longer periods that the cardiologists rediscovered the old dynamic. With the continuous recording of the heart rate and its periodicity, it became accessible to a new dimension, a dimension that requires technically well-defined foundations for accurate data collection, detailed knowledge of the electrocardiologic particularities of arrhythmia, and medical knowledge for the translation of the results into a diagnostic synthesis.

With the ECG Holter the issue is no longer just to detect an arrhythmia, but also to determine dynamic circumstance in which the critical event occurred. In fact, we investigate the trigger, the event, and the context, and we have to integrate all of that information within the clinical picture, from the pathology right through to the symptom—indeed a multi-dimensional task.

In this volume the practice of 24-hr ECG recording is elucidated in detail, including discussion of the technical bases of the recording and the potential artefacts. There is a risk of wrong conclusions because of an excess of data. Avoiding errors in the data analysis is impossible without the assistance of IT (information technology), which means that we have to rely on an automatic interpretation, at least in terms of a preliminary triage.

Rightly, great interest is attributed to the formal analysis of the ECG, but one should be cautious about overemphasising the findings. It has been wrongly concluded for too long that trivial arrhythmias, as, for example, isolated ventricular premature beats, may trigger complex arrhythmias. Wrongly, it has been assumed that pharmaceutical suppression can inhibit ventricular tachycardias and fibrillation, and this false association has dominated the rhythmology and the therapy of tachycardias for several decades. Nowadays, though, there is a concensus that the

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trigger of dangerous arrhythmias cannot be identified without knowing the specific substrate. Therefore, these authors have to be acknowledged for not having correlated the exact electrocardiographic analysis with the therapeutic need for treatment.

The 24-hr ECG is designed to relate symptoms to electrocardiographic signs. Typically though, symptoms only rarely correlate with arrhythmias. This finding may reassure an anxious patient and help to forestall further expensive investigation. On the other hand, indications for heart disorders may be detected that justify further complementary investigations. In this context the recording take on a prognostic value—and hereby we return to Tibetan medicine.

The efficiency of therapeutic intervention, such as the treatment of atrial fibrillation or the implantation of pacemakers or defibrillators, can be surveyed. The present Holter guide focuses on the exact conventional ECG analysis and leaves the way open to new analytical methods such as frequency variability and QT-variation.

Only through clear-cut clinical demand and precise data analysis will the ECG Holter contribute to the diagnosis and therapy instituted. Otherwise, the technique will dominate the diagnostic, which we would like to avoid. Rightly, Jan and Richard Adamec remind us to be cautious regarding these risks, and in so doing they underscore their extensive practical and clinical experience in exposing the highly complex, but overall transparent, method of N. J. Holter.

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Foreword II

Norman Holter introduced a new time dimension in electrocardiography, but, curiously, it took a long time for the cardiologic community to fully appreciate the value of his approach.

A quarter of a century of clinical use has passed during which there has been a technological evolution from the electronic age to the computer era, but the technique of dynamic electrocardiography is still known by the inventor's name and we prescribe a "Holter" or we read one. We might ask ourselves why we do not prescribe an "Einthoven," for the latter has the advantage of having received a Nobel Prize for his invention more than a century ago. Concerning the Holter, all the repercussions of its innovation are not yet known, but let us think about what new developments we can expect. It is not one single channel anymore, but the entirety of the surface-numerised ECG which is within reach for the whole circadian period.

This manual by Richard and Jan Adamec reflects the long-term experience of the former and we can imagine that one day it will be extended by the latter with applications which have not yet been seen in clinical practice. Everything that concerns the clinical cardiologist in the "real world" figures in these pages and, more than that, the volume also touches on the philosophy with which one should approach Holter recordings. The reading by a technician is used largely for practical reasons, but there is no more evidence in favour of giving a Holter to a technician rather than an Einthoven. Early in the use of the technique we trusted too much in the reliability and especially the appropriateness of the automatic reading, but fortunately we no longer do so. Apart from the reading by the doctor himself, the technician should understand the anecdote, that is, the electrocardiographic event, correctly and should place it in its appropriate context; at least the beginning and the end, and even better, the whole tracing. It is only then that the phenomenon takes on its proper value and that its significance can really be understood. Herein are a few examples which, incidentally, are well addressed by the authors.

The authors insist that a ventricular premature beat should not be quantified and expressed in figures alone. How dearly we paid for these types of quantifications when we wanted rhythmology to be an exact science, until we realised that is not the number that reflects the gravity of the phenomenon but the morphology, the behaviour, and the context of the premature beats. We know now that the patient who is most at risk is not the one who has the most premature beats, and that the

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most appropriate medication for his or her treatment is not the one that suppresses the largest number. By "killing" premature beats (to use the English term "premature beat killer" applied for certain types of anti-arrhythmic drugs) we have killed too many patients in the not-too-distant past. Whatever the number that specifies a dangerous premature beat, it is not the exact number but its polymorphism, its absence of dependence on the sinus frequency, and even more its appearance in the context of exercise or ischemia.

Other examples? We have often proposed to palliate the difficulty in distinguishing the P waves on a Holter during tachycardia to help with special recordings, as, for instance, the oesophageal recordings. But these pseudoadvances did not come out of the laboratory because we know from clinical experience that the diagnosis is made on the first beats of the tachycardia and/or the last ones. As long as we know the beginning and the end of the story I do not recall any rhythmological diagnosis that would have been impossible on a Holter which would have been possible on a surface ECG consisting of the arrhythmia alone. The Holter report should not consist only of the 10 sec of the tracing necessary for the diagnosis of paroxysmal atrial fibrillation. It should also contain the end of the arrhythmia looking for the post-tachycardic pause, and as well for its beginning: not the last sinus beat but the last quarter of an hour or the last hour, which will only allow us to argue for an adrenergic or a vagal mechanism. This is not an electrophysiologist reflexion just curious of physiopathology, but the thought of a clinician who knows from experience that a beta-blocker will be successful in the first case and deleterious in the second.

To a picky reviewer who one day asked me, because I could not prove it, to remove a paragraph in an article in which I was formulating the concept that all cardiac rhythm troubles were related to the nervous autonomous system, I suggested reversing the burden of proof and for him to show me evidence of a single arrhythmia in which this system would not play a role. I had no trouble then in winning my case. However, to express such an opinion is no more difficult than to say that days alternate with nights. What is difficult is to explore the different modalities of a general situation giving convincing evidence. Holter recordings have favourably influenced the rhythmologists' thinking since the 1980s, at a time when they believed they had all the keys for their discipline through provocative methods. I am sure that the present manual will arouse a comprehensive understanding of the Holter technique, which at its beginning was too rooted by its accountant style of approach.

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Preface*

Long-term ECG recording has been known for some time but has recently been further developed owing to miniaturisation, digitalisation, and an increase in memory.

First of all, the newer techniques have improved the Holter method, which was first invented in the 1960s. Moreover, devices are currently being developed which can record ambulatory ECG for several days, and subcutaneous implanted loop recording devices can monitor the heart rhythm for more than a year. However, these event recorders only detect arrhythmic events that can be predefined in a very individualised manner.

Even with this progress in computerisation, indeed probably because of it, correct electrocardiographic interpretation remains the cornerstone for the accurate diagnoses that can be obtained through these very sophisticated methods.

We thought it useful to combine the quarter of a century of experience of one of us with the approach of a young cardiologist trained in the new time and era of modern cardiology, very focused on technology. Thereby we can offer the reader of this interpretation manual not only an explanation of the advantages of the method but also an understanding of its peculiarities and limits. As put explicitly in the title, we do not want to enter into the details of the indications and therapeutic proposals, but we do want to focus on the pure electrocardiographic diagnosis. There is already much literature on arrhythmias discovered via Holter recordings, but to use it properly one first has to be sure of the electrocardiographic diagnosis.

The long-term electrocardiographic recording, also known as ambulatory ECG recording was invented by Norman J. Holter at the beginning of the 1960s, and his name was given to this new diagnostic tool. Now under the name ECG Holter we imply a recording of all cardiac complexes for at least 24 hr. Its usefulness in the diagnosis of different arrhythmias and later in the diagnosis of myocardial ischemia, especially silent myocardial ischemia, has engendered a favourable technical evolution. It has led, on the one hand, to miniaturisation of the recording device itself and, on the other hand, to the provision of three leads, so that recording can take place without limitation during daily activities and night time sleep.

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*See References 1–3, 6–8, 10, 13, 14, and 34.

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At the same time, the reading devices started to become semiautomatic and sometimes even fully automatic to accelerate the reading and offer different calculations of the events.

In principle, there are two types of reading devices: The first requires a learning process during the first reading in order to distinguish between the wide ventricular complexes and the narrow supraventricular complexes for premature beats and tachycardia, as well as to eliminate artefacts. The device then remembers the criteria introduced during the first "learning" reading and does not stop on a complex which has already been analysed, so that the second reading is done in an automatically.

The second type takes an automatic reading based on ventricular complexes considered to be normal according to templates and registers all the others as abnormal. Nevertheless, the human reader may—or even better said *must*—verify the complexes judged by the machine to be normal in order to identify any that may actually be pathological and especially to eliminate artefacts. This second device seems to work faster at first, but once one takes the time to verify the complexes and the arrhythmias this is usually no longer the case.

The speed of the lecture depends firstly on the presence or absence of the different arrhythmias and even more on the quality of the tracing and its purity. An artefact is much more easily recognised by the experienced human eye than by an automatic reading device.

All reading devices ignore atrial activity and do not recognise the P wave. The presence and the relation of the P waves with the ventricular complexes remains the key for correct diagnosis of most arrhythmias, and this escapes the automatic reading device. The performance of the automatic reading depends on this. It is optimal for the premature ventricular beats, the ventricular tachycardia, and even supraventricular tachycardia, but cannot avoid the pitfall of an intraventricular aberration. All the other arrhythmias escape detection in an automatic reading.

A new generation of devices is now at our disposal. These are digitalised recorders with memory: there is no tape so no tape-related artefacts, such as an incorrect movement of the tape, are present. These recorders need very extensive memory storage because too much compression of the signal's graphic reproduction of the cardiac activity can alter the precision of the cardiac complex.

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