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24-HOUR ECG MONITORING (LECTURE)

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Abstract. This lecture material was created to familiarize future functional diagnostic doctors with the basics of the Holter monitoring (HM) method — not only resident doctors, but also experienced doctors of other specialties during retraining. This article provides a biography of the founder of this method, Norman Holter; methodology and sequence of examination; sections such as indications for chemotherapy, the main parts of the analysis of daily monitoring are noted: heart rate, circadian index, rhythm and its disorders, myocardial ischemia, *T* wave alternans, as well as the *Q*–*T* interval. The lecture also presents historical drawings and examples from HM protocols.

Keywords: Holter monitoring, Norman Holter, 24-hour ECG monitoring

СУТОЧНОЕ МОНИТОРИРОВАНИЕ ЭКГ (ЛЕКЦИЯ)

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Резюме. Данный лекционный материал создан для ознакомления будущих врачей функциональной диагностики с основами метода холтеровского мониторирования (ХМ) — не только врачей-ординаторов, но и уже опытных докторов других специальностей при прохождении переподготовки. В статье приводится биография основоположника данного метода Нормана Холтера, методика и последовательность проведения обследования. Отмечены такие разделы, как показания к ХМ, основные части анализа суточного мониторинга: частота сердечных сокращений, циркадный индекс, ритм и его нарушения, ишемия миокарда, альтернация зубца *T*, а также интервал *Q*–*T*. В лекции представлены исторические рисунки и примеры из протоколов по ХМ.

Ключевые слова: холтеровское мониторирование, Норман Холтер, суточное мониторирование ЭКГ

One thing no one can take away from you is what you know.

The tombstone inscription on the monument to N. Holter

Holter monitoring (HM) has gained wide popularity in clinical practice — today HM is used in almost 100% of cardiac patients and very widely in other clinical entities. HM is one of the electrocardiography (ECG) techniques. However, the interpretation of ECG by means of HM has a number of significant features and limits, compared to the traditional 12-channel resting ECG. Therefore, separate attention and lecture material is required to improve educational, therapeutic and preventive processes.

BIOGRAPHY OF NORMAN HOLTER

Norman Holter was known as an inventive engineer, physicist, chemist. He had a passion for photography, biotelemetry, but what is most valuable — he made an invaluable contribution to the development of medicine (Fig. 1).

Norman's grandfather and father were entrepreneurs, they owned mines. The scientist's mother suffered from rheumatoid arthritis and often travelled long distances in search of an effective cure for her disease. This may have encouraged N. Holter to develop his talent in the field of medicine.

Fig. 1. Norman Jeff Holter [1]

Рис. 1. Норман Джефф Холтер [1]

Norman Holter attended Carroll College, the University of California, Los Angeles, where he received a master's degree in physics in 1937 and a master's degree in chemistry in 1938, after graduating from the University of Southern California. Before defending his thesis, his supervisor Emil Starz said: "I know you will make discoveries in your chosen profession, conscious of the fact that science will still hear from you in the years to come. I wish you success and fortitude to definitively prove your knowledge". Holter later graduated from the University of Heidelberg in Germany, the University of Chicago, the Oak Ridge Institute for Nuclear Research and Oregon Medical School. During World War II, Holter served as a senior physicist in the U.S. Navy, studying the physical characteristics of ocean waves.

Fig. 2. The original Holter biotelemetric apparatus, manufactured in 1947. It was used to broadcast electroencephalograms and electrocardiograms using coarse heavy battery equipment of almost 40 kg [1]

Рис. 2. Оригинальный биотелеметрический аппарат Холтера 1947 г. выпуска. Использовался для трансляции электроэнцефалограммы и электрокардиограммы с использованием грубого тяжелого аккумуляторного оборудования весом почти 40 кг [1]

Fig. 3. Visual use of one of the first XM ECG devices [2]

Рис. 3. Наглядное использование одного из первых приборов ХМ ЭКГ [2]

In 1946, he led a government research team testing an atomic bomb at Bikini Atoll. Upon returning home, Norman began mapping radioactive fallout of nuclear tests carried out by the United States and the Soviet Union. The Atomic Energy Commission subsequently engaged Holter to research the hydrogen bomb at Eniwetok Atoll.

In 1956 the development of nuclear medicine began — radioisotope diagnostic methods were used for the first time. N. Holter was one of the first to realize the therapeutic possibilities of radiation. He believed that radioactive substances should be used in medicine. Probably, that is why he decided to organize the Montana Nuclear Medicine Society, where nuclear medicine began. Holter was the president of the Society for nearly 13 years.

In 1939, Holter began working with Joseph E. Gengerelli. The idea behind the work was to induce muscle contraction without mechanical or electrical contacts. The scientists reproduced muscle contraction by applying an alternating electric field to a nerve. After confirming their idea, they came to the conclusion that an electric field excites a nerve, and the nerve itself creates a magnetic field that can be registered. In 1961, it became technically possible to confirm their theory. J.E. Gengerelli and N. Holter conducted their experiments on rats, stimulating their brains at a distance: they implanted electrodes in the skull and attached a miniature radio receiver, and then observed the behaviors of the test animals when playing with the radio at different frequencies.

The out-of-the-box thinking led Holter to develop a method for long-term recording of electrocardiograms with data storage and the ability to analyze them in the future (Fig. 2).

In 1947, Norman established the Holter Research Foundation with his own funds.

Officially, HM was created in 1961, when the American journal Science published an article by Holter entitled “A New Method of Cardiac Research. Practical use of prolonged electrocardiography in patients in the active period”. The cassettes and batteries used at that time made it possible to record one ECG channel continuously for 10 hours.

In 1962, joint work with Dr Eliot Corday began at Cedars-Sinai Hospital (Los Angeles), where the first clinical prototype of the Holter monitor was tested. The device was tested on 200 patients with ischemic changes and extrasystole.

The result was a classic publication in the Journal of the American Medical Association (JAMA) issued in 1965 “Detection of Hidden Arrhythmias and Transient Electrocardiographic Abnormalities” (Fig. 3).

The method has been actively used in clinical practice since 1963.

METHOD DEFINITION AND USED TERMINOLOGY

In Russia, the terms “Holter monitoring” (HM) or “daily monitoring” (DM ECG) are used.

In the USA and Europe, the method is more commonly referred to as “outpatient ECG monitoring”, “dynamic electrocardiography”, “daily ECG monitoring”, “Holter monitoring”.

WORK SEQUENCE

1. Preparation of a monitor for work (installation of accumulators, batteries, checking their charge and cable suitability, preventive maintenance of the monitor).
2. Preparation of a patient, explanations, selection of a research protocol.
3. HM ECG examination.
4. Receipt of data, their processing, evaluation by a doctor of functional diagnostics, drawing a conclusion.
5. Data archiving (if necessary), data erasure.

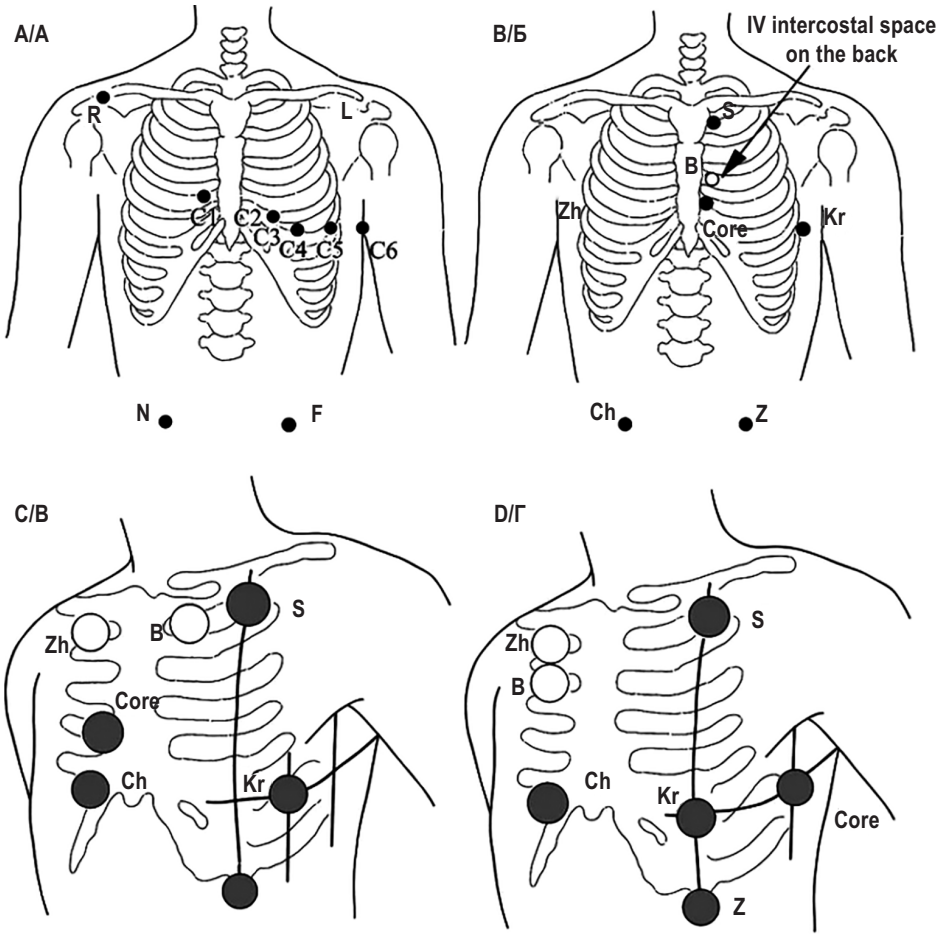

Fig. 4. **Twelve standard ECG leads (chest electrodes are located at standard points C1–C6, and electrodes from the limbs are transferred to the ends of the clavicles and to the iliac crests) (A); three orthogonal leads for recording late ventricular potentials according to Simpson (Б); system of monitor leads Vim, V5m, Y, most suitable for diagnosing rhythm disturbances (B); the V4m, V6m, Y system is most suitable for diagnosing myocardial ischemia (D). The colors of the electrodes are indicated: Zh — yellow; B — white; Ch — black; S — blue; Z — green; Core — brown; Kr — red**

Рис. 4. **Двенадцать стандартных отведений ЭКГ (грудные электроды располагаются в стандартных точках С1–С6, а электроды с конечностей переносятся на окончания ключиц и на гребни подвздошных костей) (А); три ортогональных отведения для регистрации поздних желудочковых потенциалов по Симпсону (Б); система мониторных отведений Vim, V5m, Y, максимально пригодная для диагностики нарушений ритма (В); система V4m, V6m, Y максимально пригодна для диагностики ишемии миокарда (Г). Обозначены цвета электродов: Ж — желтый; Б — белый; Ч — черный; С — синий; З — зеленый; Кор — коричневый; Кр — красный**

VARIANTS OF THE EQUIPMENT USED

1. **Monitors with permanent recording.**

2. **Monitors with intermittent recording** (*event recorder),* including implantable loop heart rate recorders that can monitor ECG rhythm for months with wireless transmission to a service centre.

LEAD SYSTEMS USED

Two or three-channel ECG recording: two bipolar modified leads VI and V5 or three leads such as V5, AVF and II standard leads, which are close to the cardiac orthogonal axis directions.

1. The most orthogonal system of 7 electrodes with formation of three leads: type V5, AVF and V3, reflecting three axes — horizontal, vertical and sagittal ones.

2. Systems of three ECG leads formed by seven electrodes are increasingly used and are the closest to Frank's orthogonal system.

3. In recent years, almost all manufacturers have marketed monitors with the ability to record 12 ECG channels, identical to the 12 channels on the resting ECG or stress test (Fig. 4) [3].

INDICATIONS FOR DAILY ECG MONITORING

The indications for daily ECG monitoring are as follows [3].

Class I

1) Patients with unexplained syncopal and presyncopal states or episodic dizziness (with no identified noncardiac cause).

2) Patients with unexplained recurrent heart palpitations.

Class II

1) Patients with episodic dyspnoea, chest pain or unexplained weakness.

2) Patients with neurological pathology if transient atrial fibrillation/atrial flutter is suspected.

3) Patients with symptoms such as syncopal and presyncopal states, episodic dizziness or palpitations for which a different (non-arrhythmic) cause has been identified but symptoms persist despite receiving aetiotropic treatment.

Class III

1) Patients with symptoms such as syncopal and presyncopal states, episodic dizziness or palpitations who are determined to have another cause on examination.

2) Patients with cerebrovascular disorders without other evidence of arrhythmia.

AIM

1. Heart rate (HR) per day, daytime and nighttime, their ratios.
2. Variability of R-R intervals (analysis of autonomic regulation and adaptation mechanisms of circulatory system regulation) and *Q*–*T* interval.
3. Rhythm and conduction disorders (calculation of their number and characteristics).
4. Adequacy of antiarrhythmic therapy (if arrhythmia is reduced by 75% — the treatment is adequate), control of other types of treatment.
5. Changes in repolarization (ischemic, dystrophic ones).
6. Evaluation of the effectiveness of electrocardiostimulation (ECS).
7. Evaluation of ventricular late potentials.
8. Assessment of exercise tolerance.

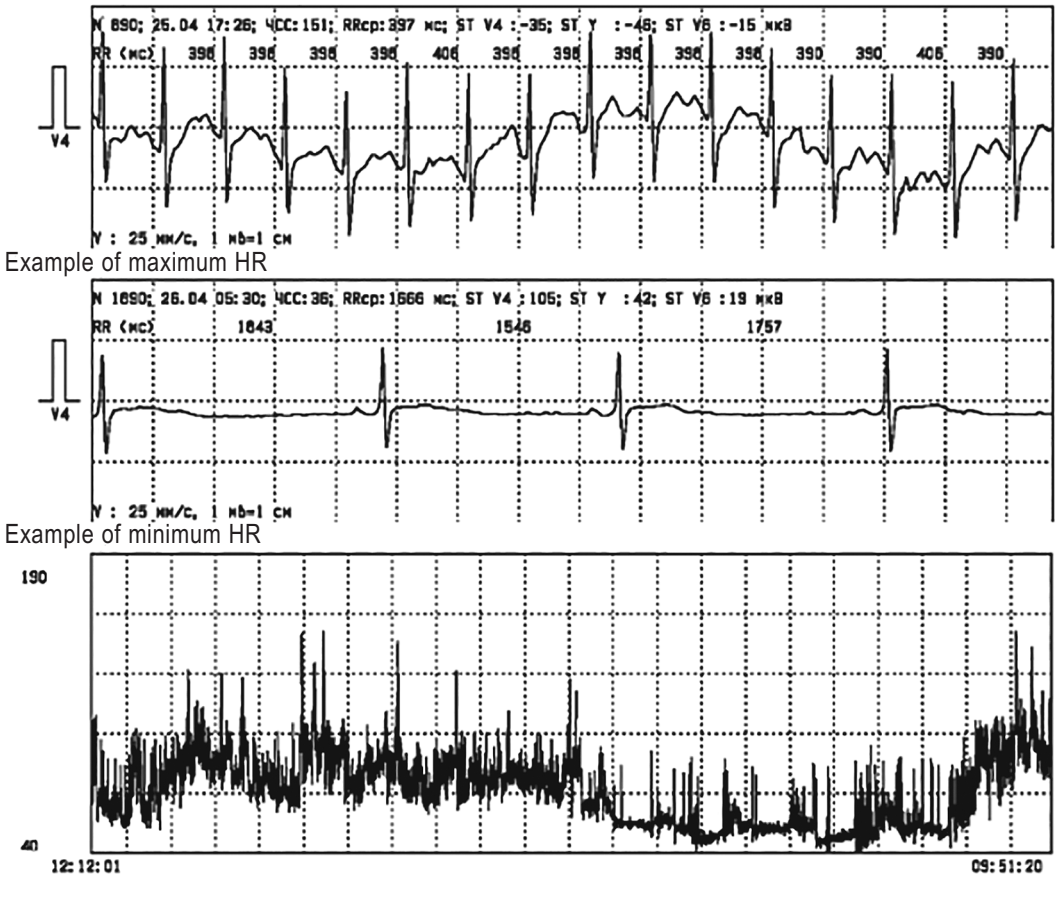

Fig. 5. Graph of heart rate values [40]

Рис. 5. График значений ЧСС [40]

RHYTHM AND ITS ABNORMALITIES IN HEALTHY INDIVIDUALS

Assessment of HM results begins with the estimation of the HR [3]. Average daily parameters, as well as maximum and minimum values of HR per day are distinguished (Fig. 5).

Note that the rhythm in HM ECG differs from the standard ECG throughout the day.

Average daily HR reaches 70–100 beats per minute (in women — 83–86, in men — 79–86). There is also a correlation with age (Table 1) [4–6].

The average overnight HR varies between 55–70 beats per minute (64–70 in women, 56–62 in men), nocturnal HR reflects the "baseline rhythm" and is little affected by age.

Table 1

The average daily values of the percentile (%) distribution of heart rate (bpm) in XM in healthy individuals aged 20–90 years [3]

Таблица 1

Среднесуточные значения процентильного (%) распределения ЧСС (уд./мин) при ХМ у здоровых лиц 20–90 лет [3]

Возраст (лет) / Age (years)	ЧСС (уд./мин) / Heart rate (bpm)		
	50%	5%	95%
20–29	79	56	104
30–39	78	55	103
40–49	78	54	102
50–59	76	53	100
60–69	77	52	99
70–79	72	51	98
80–89	73	49	97

CIRCADIAN INDEX

The circadian index (CI) is defined as the ratio of daytime HR to nighttime HR.

There is no significant sex-age difference in healthy individuals, and this index is 1.24–1.44 [7].

An increase in CI is observed in the following conditions: pronounced vagotonia in the evening and at night, persistent sinus tachycardia during the day (emotional, physical stress, vagotonic sinus node dysfunction). Reduced CI: persistent sinus tachy-, bradycardia, rigid rhythm (sinus node weakness syndrome, diabetic cardiovascular autonomic neuropathy, tetraplegia, heart transplantation, etc.).

NB! A functional diagnostician should check sleep time in an HR chart.

Depending on the obtained CI, a circadian profile of a patient is derived. In a normal circadian profile, the CI corresponds to 1.24–1.44. Rigid circadian HR profile (signs of "autonomic denervation") corresponds to CI <1,2. Enhanced circadian profile or increased sensitivity of heart rhythm to sympathetic influences corresponds to CI >1.45 [3].

SINUS ARRHYTHMIA

In contrast to standard ECG, the variation of adjacent *R–R* intervals is higher. Possible variants of sinus arrhythmia in DM ECG are: mild — *RR* fluctuations up to 15% (more often in the elderly), moderate — with *RR* fluctuations of 50–100%; severe — fluctuations of more than 100%, which makes it almost impossible to detect sinoauricular blockade.

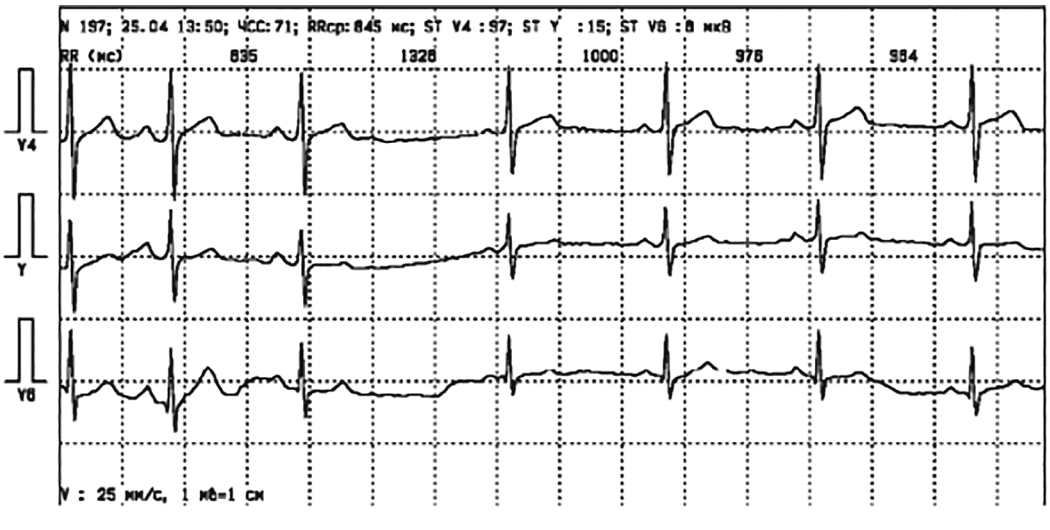

Fig. 6. Migration of the rhythm driver [40]

Рис. 6. Миграция водителя ритма [40]

NB! It is more correct to use the term "pauses on the background of sinus arrhythmia" and to take into account their duration: up to 1.5 s — in 31–68% of healthy people, 1.5–2 s — in 25% of young men, over 2 s — in 1–2% [3, 7, 8].

When detecting prolonged pauses, it is necessary to distinguish clinically significant pauses from clinically insignificant ones. Thus, pauses over 2 s are considered pathologic and require further follow-up examination. Pauses of 1.5 s or more should be treated with caution in elderly patients.

PACEMAKER MIGRATION

Rhythm driver migration across the atria is detected at night in the majority of healthy people (54%), and is more characteristic for young people. Rhythm driver migration to the AV junction ("nodal" rhythm) is rare in healthy people — 2–9% and is a reason for further examination (Fig. 6) [9, 10, 40].

AV CONDUCTION AND ITS DISORDERS

AV conduction disorders occur in healthy patients in 2–8% of cases, they are usually asymptomatic (at night — on the background of bradycardia). AV-blockade of the I degree is the most frequent, II degree AV-blockade of the Mobitz 1 type is less frequent.

NB! Increase of *P–Q* interval on the background of bradycardia (HR less than 50 per minute) up to 240–260 ms is natural and should not be interpreted as AV conduction disorder.

RHYTHM DISTURBANCES

Special software decodes a 24-hour recording and presents a total number of complexes as "normal", "ventricular", "artifactual" and "unknown" (other variants are possible), as well as arrhythmia classes [3]. All arrhythmia classes should be assessed and confirmed visually by an experienced clinician who is familiar with features of arrhythmia assessment in HM. It is important to keep in mind possible false-negative and false-positive detections of arrhythmias.

According to the ACC/AHA guidelines, the following reasons for such identifications are emphasized [11]:

1) inadequate algorithm of computerized detection and identification of *QRS* complexes;
2) "noise" and flooding, electrode displacement, artifacts;
3) low recording voltages;
4) recording defects due to violation of recording speed or recording to another carrier;
5) physiologic variability of *QRS* complex shape and voltages;
6) incomplete deletion or erasure of a previous recording from the carrier;
7) inadequate or incorrect technical interpretation during the analysis;
8) incorrectly time labeled [3].

Arrhythmia analysis

According to the results of various studies, supraventricular extrasystole (SVE) is registered in adults in 56% of cases during HM in healthy individuals [3, 12–15]. In healthy individuals, ventricular extrasystole (VES) is recorded in 70% of adult patients in the same studies [16, 17]. In healthy individuals, single paired extrasystoles and volleys of ventricular tachycardia of no more than three consecutive contractions are also registered (Fig. 7, 8). It is important to take into account that no more than four consecutive complexes will be considered as group extrasystole. If there are 5 or more complexes, it is legitimate to speak about a tachycardia paroxysm [7]. It should also be noted that identification of SVE and LES from each other seems obvious, but in practice it is not so simple, although it is very important.

ST SEGMENT ANALYSIS IN HOLTER MONITORING

It is important that the rhythm is sinus rhythm. Initial *ST* segment displacement should not exceed 0.1 mV, in morphology

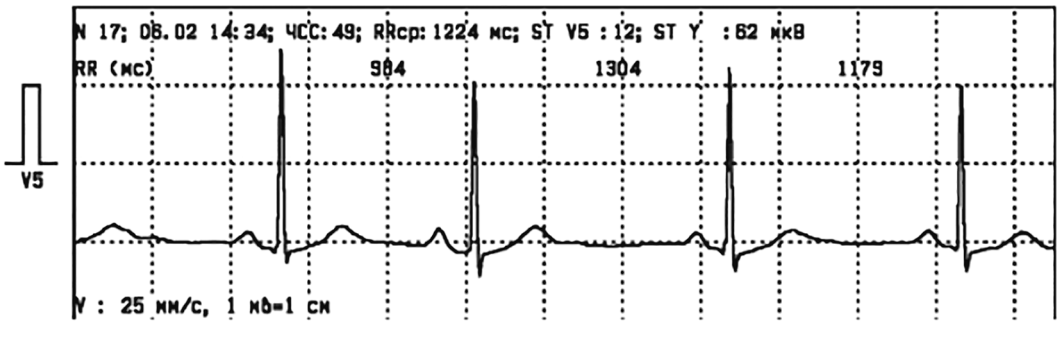

Fig. 7. Single supraventricular extrasystole [40]

Рис. 7. Единичная суправентрикулярная экстрасистола [40]

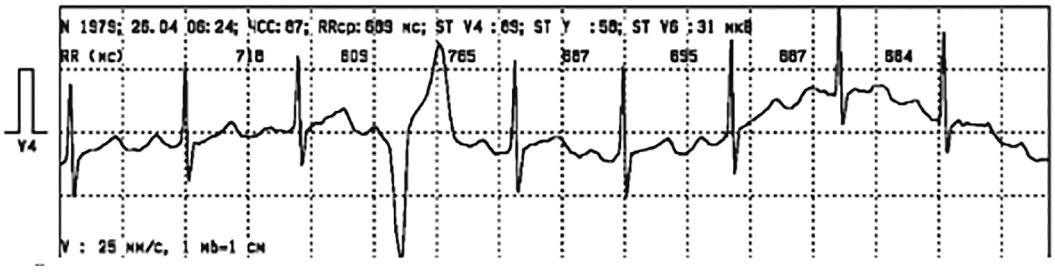

Fig. 8. Single ventricular extrasystole [40]

Рис. 8. Единичная желудочковая экстрасистола [40]

it should be with a positive T tooth. For adequate assessment of the *ST* segment, the height of the *R* tooth in the monitored lead should be ≥10 mV. Patients with evidence of left ventricular hypertrophy (LVH), signs of preexcitation, left bundle branch block (LBBB), or nonspecific intraventricular conduction abnormalities with a delay of ≥0.10 s are not suitable for assessment of myocardial ischemia by CM. The leads selected for ischemia monitoring with CM should not have *Q* teeth of ≥0.04 s duration and a pronounced baseline *ST* segment shift. It is necessary to exclude the influence of drug therapy on the study period (cardiac glycosides, antiarrhythmics, antidepressants).

Ischemia is identified as a sequence of the following ECG changes: horizontal or oblique *ST* segment depression ≥0.1 mV with gradual onset and termination that lasts for at least 1 minute.

Kodama classification [18] is most commonly used in practice in order to confirm and describe myocardial ischemia during HM:

1. Horizontal or descending *ST* segment decrease of 0.1 mV at a point 80 ms from the *J* point and lasting at least 1 minute. The sensitivity of the criteria for men is 93.3% and specificity is 55.6%; for women it is 66.7% and 37.5%, respectively.
2. *ST* segment elevation of 0.1 mV lasting 80 ms from the point *J*.
3. Episodes of *ST* elevation and *ST* segment depression.
4. *ST*/HR index that is equal to 1.4 mV/ud/min. Sensitivity of ischemia detection — 80%, specificity — 64.7%.

Ellestad criteria [19] for describing an episode of myocardial ischemia during HN are also used:

1. Horizontal or oblique *ST* segment depression that lasts 80 ms after the end of the *QRS* complex. *J* point depression should reach at least 1 mV.
2. Oblique slow *ST* segment depression that lasts at least 80 ms from the *J* point, the *ST* segment that is 80 ms away from it should be reduced by at least 2 mV.

The *ST* segment, as well as HR, is subject to circadian influences. Thus, during daytime and morning hours, the *ST* segment may have a slanting shape with *J* point depression under increased sympathetic influence. At night hours, saddle-shaped *ST* segment elevation may be registered as a result of vagus influence [3].

In practice, it is very important to distinguish true myocardial ischemia from false-positive or false-negative myocardial ischemia. According to ACC/AHA (American College of Cardiology / American Heart Association) guidelines, the following causes of false identifications are distinguished [3]:

1) *ST* segment positional changes;
2) hyperventilation;
3) sudden significant *ST* segment changes at the peak of physical activity;
4) vasoregulatory or vagus (Valsalva) induced *ST* segment changes;
5) intraventricular conduction disorders;
6) undiagnosed left ventricular hypertrophy;
7) *ST* segment changes due to tachycardia;
8) false-positive *ST* segment changes on the background of atrial fibrillation;
9) *ST* segment changes due to electrolyte disorders;
10) inadequate formation of leads for recording;
11) incorrect calibration of leads;
12) signal recording system that changes *ST* segment.

All these reasons must be taken into account during medical interpretation of HM. It is not allowed to rely blindly on machine identification!

A marked oblique *ST* depression with a *J* point decrease of more than 1 mV is absolutely normal in tachycardia. Moreover, *ST* elevations over 1 mV may be recorded in severe bradycardia and early repolarization syndrome/phenomenon.

It is important to remember that changes in the *T* wave (final ventricular deflection) are often nonspecific. Visual alternation phenomenon is also interesting. It is an alternation of positive and negative *T* wave, and it indicates a high degree of myocardial electrical instability [3]. International Recommendations for the Prevention of Sudden Cardiac Death (SCD) [20, 21] include the assessment of *Q–T* interval and visual alternation of the *T* wave during HM (A of evidence) in the first class of indications in risk groups.

There are two methods of estimating the MAT (microvolt alternation of the *T* wave) — these are spectral and temporal ones. The spectral (Conventional Spectral based method or Cambridge Heart method) method can be used only in stress test and transesophageal stimulation when a certain HR is reached [22] and is not suitable for analysis during HM [23]. The temporal method of MMA (Modified Moving Average) can also be used in HM [24]. Studies [25, 26] have shown that a cut-off point value of MMA above 65 microvolts (μV) is associated with a risk of high mortality in the adult population [23]. MMA values should not exceed 55 μV in healthy individuals in all age groups [27]. In case MMA values are higher than 65 μV in adults and 55 μV in children, they can be reflected in the HM report as a manifestation of myocardial electrical instability and can be interpreted as a risk factor for the development of life-threatening arrhythmias [3].

EVALUATION OF THE *Q–T* INTERVAL DURING HOLTER MONITORING

Q–T interval estimation is an extremely important element in the analysis of HM. According to international guidelines for the prevention of sudden cardiac death (SCD) [20], assessment of the *Q–T* interval during HM is a 1A grade indication to perform HM in individuals with a high risk of developing life-threatening rhythm disturbances [3].

The range of normal values of the *Q–T* interval during HM is still debatable. It is known [3] that the clinical standard for resting ECG is the calculation of corrected *Q–T* interval (*Q–Tc*) using the Bazett formula (*Q–T*/the square root of the preceding *RR* interval) or (much less frequently) the Fredericia formula (*Q–T*/cubic root of the preceding interval) *R–R* [3]. However, only maximum absolute *Q–T* interval can be determined during manual analysis of HM, which is measured at the minimum HR. According to different data [3, 28–38], it can be concluded that the maximum values of the mean daily *Q–Ts* in healthy individuals at automatic calculation in different HM systems do not exceed 450 ms in adults and 480 ms in children. Sex differences are presented in Table 2.

Table 2

Sex differences between *Q–T* and *Q–Tc* in HM [3]

Таблица 2

Половые различия *Q–T* и *Q–Tc* при ХМ [3]

Интервал, мс/ Interval, ms	В целом по группе / Total	Женщины / Females (n=28)	Мужчины / Males (n=29)
Q–T	367±18	368±18	367±17
Q–Tc	409±15	417±12	401±13

Dynamic evaluation of daily adaptation parameters of *Q–T* interval to HR also deserves attention. The so-called *QT*-dynamics is performed to identify the parameters of daily adaptation of the *Q–T* interval to HR, i.e. the higher the slope *QT*/*RR* (slope *QT* is a method of manual calculation of *Q–T* interval duration), the more the *Q–T* interval shortens during tachycardia and lengthens during bradycardia, and vice versa [3]. Based on this approach, the concept of "hyper- and hypoadaptation" of *Q–T* to HR was proposed, which defines "hyperadaptation" at values of daily slope *QT*/*RR* greater than 0.24 and "hypoadaptation" at its values less than 0.13 [34]. "*Q–T* hyperadaptation" is characteristic for patients with heart failure, myocardial infarction and the third type of *Q–T* prolongation syndrome, "*Q–T* hypoadaptation" — for patients with Brugada syndrome and the first type of *Q–T* prolongation syndrome.

ANALYSIS OF VENTRICULAR LATE POTENTIALS

This technique is based on the analysis of low-amplitude (less than 20 μV), high-frequency (over 20–50 Hz) signals at the end of the QRS complex — ventricular late potentials (VLPs), reflecting delayed, fragmented activity occurring in heterogeneously changed myocardium. The program automatically processes the *QRS* complex with the help of time-domain analysis. On the basis of the latter, a conclusion is made if there are signs of VLPs. It is worth mentioning that the method was supposed to be used in HM for complex analysis of heart rhythm. However, a certain number of technical difficulties, such as the presence of artifacts and variability of adhesion, do not allow to introduce the technique into standard programs in HM. Even now, according to our experience, qualitative analysis of VLP is possible only when using the most modern computer algorithms of decoders in commercial HM systems.

Thus, according to the automatic analysis of VLP in HM, we can distinguish two groups of patients: with or without late potentials [39]. The following parameters served as a criterion for late potentials in HM:

1) tot*QRS* (*QRS* duration) ≥120 ms;
2) rMS40 (*QRS* amplitude of last 40 ms) ≤25 μV;
3) LAS40 (duration <40mV) ≥39 ms. Patients with myocardial infarction appeared to have a circadian rhythm of LAS registration [3].

DRAWING A CONCLUSION

The main task of a functional diagnostics doctor is to provide a treating physician with the most objective document which must reflect all parameters of the examination.

The conclusion should reflect:

1) the rhythm registered during the observation period, rhythm change (in hours and minutes);
2) HR dynamics (according to CI), max and min HR during the day and night;
3) heart rate variability indices (reflection of VNS activity);
4) detected rhythm and conduction disturbances (quantitative and qualitative assessment) not only in the report itself, but also in the arrhythmia graph (distribution per day), as well as in the protocol with visual examples;
5) *ST* segment changes (ischemic, dysmetabolic, mixed type);
6) assessment of *Q*–*T* interval variability, VLP (if possible);
7) assessment of exercise tolerance.

NB! The purpose is to relate these indices to each other, to correlate them with subjective feelings of a patient according to his diar

CONCLUSION

This lecture contains basics required to analyze the results of Holter ECG monitoring. Holter monitoring provides information that cannot be obtained by analyzing an electrocardiogram recording of a few seconds. It is a flexible and informative tool in talented and professional hands.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

Competing interests. The authors declare that they have no competing interests.

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ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

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