

Clinical trials of a personal electrocardiograph

**A Boyakhchyan¹, I Lezhnina¹, K Overchuk¹, V Perchatkin², A Lvova³
and U Alexander⁴**

¹Tomsk Polytechnic University, Tomsk, Russia

²Head of the Department of Rehabilitation of Patients with Cardiovascular Diseases, Cardiology Research Institute, Tomsk, Russia

³Postgraduate Student, Cardiology Research Institute, Tomsk, Russia

⁴Project manager, DI-Group, Moscow, Russia

E-mail : inna84-08@mail.ru

Abstract. The article describes the results of a clinical trial at the Cardiology Research Institute in Tomsk. Clinical trials were conducted to identify different important information for diagnosis. These tests were also conducted to remotely monitor the treatment of patients who had already been discharged from the hospital. The study involved 15 patients, the most interesting cases are described in this article.

1 Introduction

At present electrocardiography allows to diagnose and control many conditions and pathologies of the heart: various rhythm/conduction disorders, control the therapy of certain medications, etc [1].

Electrocardiographs are a complex device that should be managed by a specialist who has special skills and is able to correctly register an ECG, which absolutely excludes the possibility of using this equipment outside the cardiologist's office.

To solve this problem, developed a personal electrocardiograph. To verify the appropriateness of using such a device, were conducted clinical trials [2–6].

Research s plan:

- Tests are carried out by practical application of ECG-Express devices on patients with selected groups of heart diseases.
- Patients use devices to self-register the ECG during the onset of symptoms, and also on a regular basis as directed by doctor.
- For the measurement, different ECG leads are selected depending on the location of the expected signs in different leads: according to the standard arrangement of the device in the center of the chest, and in other positions [6–12].

2 Materials and methods

During the testing period, the device was given to 15 patients for a period of one to two weeks for regular using. A common feature for each individual case was that at previous diagnostic stages it was not possible to clarify the diagnosis. Patients had rare complaints about the heart, and with daily monitoring of ECG Holter pathology could not be registered.

The study group of patients included:

- 3 patients with IHD (ST segment ECG inversion);
- 2 patients with myocarditis (inversion of the T wave);



- 2 patients who control the dose of antiarrhythmic drugs;
- 8 people with various heart rhythm disturbances.

For registration of ECG, was used a personal electrocardiograph "ECG-Express" – development of scientists from Tomsk Polytechnic University (Figure 1).



Figure 1. The device "ECG-Express".

The device satisfies a number of basic requirements set out in the development of:

- Device is personal and mobile so that the patient can use it in any life situation.
- Measurement occurs from the surface of the chest, because it chest leads registration provides important information for the diagnosis.
- Measurement is equally qualitative and stable in people with different individual characteristics: chest anatomy, hair density, contamination and skin condition.

The ECG is recorded for 50 seconds, with 3 chest leads. By means of mobile communication, information is sent to the server from which the doctor in the specialized application performs an ECG analysis. All records are stored on the server and computer of the doctor in chronological order. This device was offered to patients who were discharged from the hospital and continued treatment on an outpatient basis. Patients independently used it at home.

3 Results

During the testing of the device, a number of special cases were singled out, when the application of the device made it possible to identify symptoms that could not be fixed by standard methods. The following is a description of the main, most significant, cases.

In other cases, using a device able to confirm the diagnosis made in a standard way of ECG registration. All ECG was opened and filtered in MatLab. Screenshots with filtered signals are presented below. MatLab has a Russian interface and all screenshots below from MatLab.

The patient is a man, 42 years old. He was at the Research Institute of Cardiology on examination and treatment with a diagnosis: IHD. On an outpatient basis he complained of pain in the chest like pressing. Patient independently used a personal electrocardiograph (Figure 2), thanks to which it was possible to register changes in the T wave. He was hospitalized, was revealed postmyocardial cardiosclerosis.

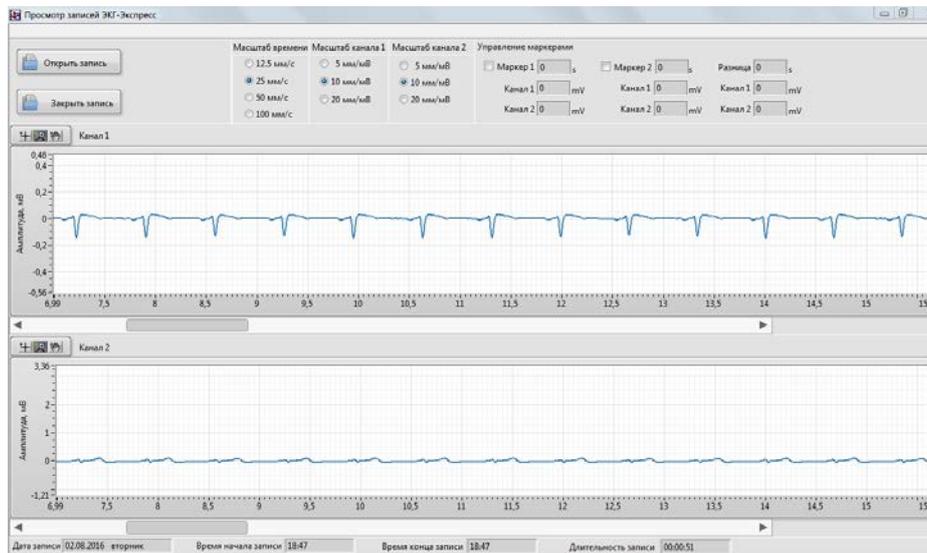


Figure 2. Screen of ECG of the first patient.

The patient is a man, 78 years old with a diagnosis: ischemic heart disease and paroxysmal ventricular tachycardia. This patient is stable heavy as it has damage to the spine, and therefore is always at home. Bthe possibility to visit outpatient clinics and to be constantly monitored by a doctor is not available for patient. Suddenly, in this patient there was deterioration. The use of a personal electrocardiograph made it possible to diagnose the onset of paroxysm of atrial fibrillation and in time to call for an ambulance, without waiting for the further development of negative symptoms.

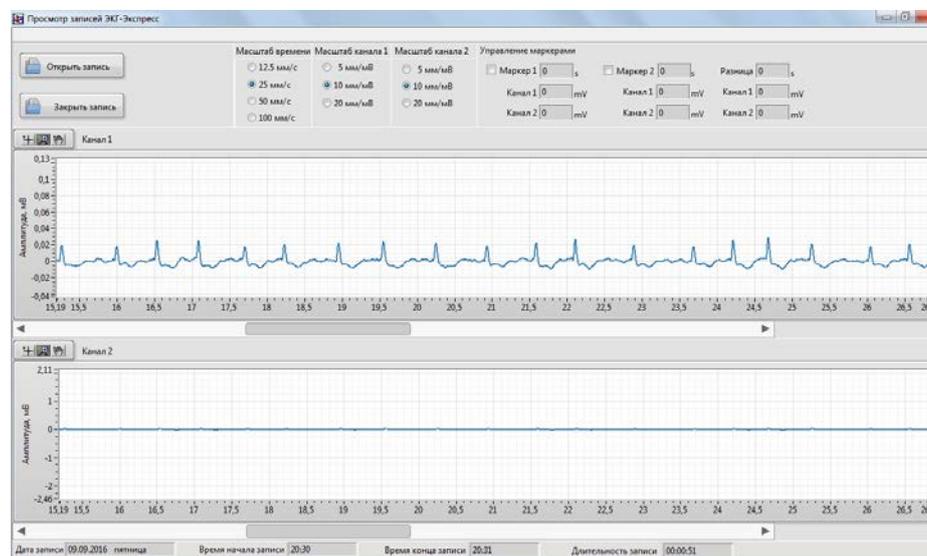


Figure 3. Screen of ECG of a patient with ischemic heart disease.

The patient is a young man, 17 years old. The young man complained of sudden attacks of palpitations. Repeated daily monitoring of ECG pathology did not reveal. With the help of a personal electrocardiograph (Figure 3), it was possible to diagnose paroxysms of supraventricular tachycardia. Later the patient was treated in the arrhythmology department.

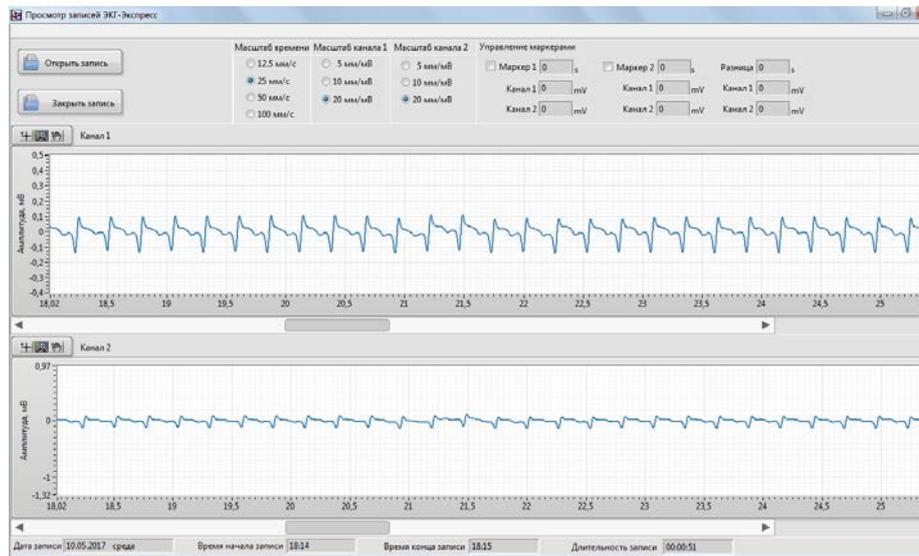


Figure 4. Screen of ECG of the patient with tachycardia.

Patient is a man of 52 years old. Was observed outpatient with the therapist at the place of residence. Was consulted by one of the staff of the Institute of Cardiology. He complained of fits of heart failure, accompanied by mild dyspnea, weakness, suddenly started, lasted 3–5 minutes and self-stopped. These episodes arose several times a month. Conducting daily monitoring of the ECG in this case was not informative. The patient used a personal electrocardiograph (Figure 4) while in another city. It was possible to establish the probable cause of the described seizures and record a rhythm disorder - episodes of frequent ventricular extrasystole. After the examination in the cardiological hospital, the following diagnosis was made: Chronic nonspecific focal myocarditis.

4 Conclusion

Analyzing the obtained data, it can be concluded that a personal electrocardiograph can be used for:

1. Detection of irregular heart rhythm disturbances, which can not always be detected with the help of 24-hour ECG monitoring.
2. Receiving valuable information for diagnosis (ECG recording during an attack).
3. To establish possible episodes of myocardial ischemia.

When registering the ECG, patients did not notice any difficulties in using the device. The ability to transfer a record immediately to the doctor's workplace allows you to react immediately, and take appropriate measures, while the patient can be thousands of miles away from clinic.

References

- [1] Montalescot G., Sechtem U., Achenbach S., Andreotti F *et al.* 2014 *European Heart Journal* **35** (33) 2260–2261 doi :10.1093/eurheartj/ehu038
- [2] Lezhnina I A, Boyakhchyan A A, Overchuk K V and Uvarov A A 2017 *IOP Conf. Ser.: Mater. Sci. Eng.* **881** 012041 doi : 10.1088/1742-6596/881/1/012041
- [3] Avdeeva D K, Kazakov V Y, Natalinova N M, Maksimov I V, Balahonova M V 2014 *Biology and Medicine* **6**(2) BM-025
- [4] Bordunov S V 2016 *IOP Conference Series: Materials Science and Engineering* **110** 012094 doi: 10.1088/1757-899X/110/1/012094
- [5] Kazakov V Y, Avdeeva D K, Grigoriev M G, Natalinova N M, Maksimov I V, Balahonova M V 2015 *Biol Med (Aligarh)* **7**(5) BM-155-15
- [6] Natalinova N, Ilina N, Frantczuskaia E 2016 *IOP Conf. Ser.: Mater. Sci. Eng* **132** 012029

- [7] Montalescot G, Sechtem U, Achenbach S, Andreotti F *et al.* 2013 *European Heart Journal* **34** (38) 2949–3003 doi : 10.1093/eurheartj/eh296
- [8] Golitsyn S, Kropacheva E and Maikov E *et al.* 2013 *Federal clinical guidelines for the diagnosis and treatment of cardiac arrhythmias and conduction: wedge.* (Moscow , Recommendations)
- [9] Komolyatova V, Kupriyanov O, Pervova E and Ryabykina G 2014 *Russian Cardiology Journal* (2) 6–71 doi : 10.15829/1560-4071-2014-2-6-71
- [10] Yartsev S 2014 *Electrocardiography: a practical guide-guide for doctors* (Moscow, RUDN)
- [11] Plotnikova I V *et al.* 2018 *IOP Conference Series: Materials Science and Engineering* **289** 012029 doi:10.1088/1757-899X/289/1/012029
- [12] Axelrod A, Chomakhidze P and Syrkin A 2007 *Holter monitoring of ECG: possibilities, difficulties, errors* (Moscow, Medical Information Agency LLC)