Short report

Cardiometry: pioneering experience in assessment of the heart performance and evaluation of fatal arrhythmia risks in intensive care unit patients

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Abstract

In the paper presented is an application study of the heart performance phase mechanism with the use of the Cardiocode analyzer based on principles of cardiometry for evaluating iatrogenic complications caused by antiarrhythmic therapy and monitoring the quality of treatment of hemodynamic disorders in in-hospital intensive care units. The aim of the study is a thorough estimation of the diagnostic and functional quality of the performance of the Cardiocode device and developing a new methodology of its application under the conditions of the intensive care units, when predicting fatal arrhythmia progression. 50 patients with true cardiogenic shock of different degrees of severity have been examined with Cardiocode. As a result, it is established that the application of the heart cycle phase analysis in diagnostics, hemodynamics evaluation and management with the medication and infusion therapy supported by the Cardiocode device allows reducing the mortality rate by 32 ± 3.4 %.

Keywords

Iatrogenic complications • Antiarrhythmic • Treatment quality • Cardiogenic shock • Mortality • Heart cycle phase analysis • Cardiocode • Cardiometry

Imprint

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Introduction

In the Russian Federation, the mortality rate caused by cardiovascular system is one of the most critical in the world and reaches 1462 deaths per 100.000 people a year. Besides the primary and secondary myocardial fibrillation amount to 86% of cardiac arrests, and the causative agents of the genesis of fibrillation are varied. The main cardiovascular system death causes are as follows: progression of chronic heart failure (nearly half of all lethal outcomes) and sudden cardiac death (SCD) (the other half of the lethal outcomes). According to the statistics, every year 200.000-250.000 people suddenly die of cardiac diseases in Russia. Actually, the problem of SCD is extremely urgent

for the Russian National Health Service. A great interest to the problem is also determined by the fact that the SCD rate is increasing. Nevertheless it is obvious that there is a possibility to use effective preventive measures for improving the existing situation [1, 2].

The main cause of the death is progression of fatal rhythm disorders, but the arrhythmias are connected not only with electrical activity disorders, but also with the contraction function disorder, and it follows that the cause of arrhythmia is a disorder in a synchronous interaction between the electrical and mechanical processes in myocardium [3]. The iatrogenic cases which are very often associated with an application of the 1st class antiarrhythmic medication, digitalis and some pharmaceutical like tricyclic antidepressants and phenothiazides, which extend the QT interval, are widely represented in literature. It was shown long ago that the 1st class antiarrhythmic drugs have a paradox pro-arrhythmic activity effect in case of heart pathology. To regret, this phenomenon has been confirmed by the recent CAST program investigations where it has been shown that the cases of SCD are more frequent in the group of asymptomatic post MI patients with ventricle ectopia treated with flekainid and encainid than it is the case in the group of patients who did not receive the treatment.

Materials and methods

The PC-assisted hemodynamic analyzer Cardiocode is designed for the electrocardiogram (ECG) recording in one lead with the synchronous rheogram (Rheo) recording and automatic calculation of the cardiovascular system hemodynamic parameters using phase durations and qualitative evaluation of the given parameters [4-8]. The severity of a patient state is evaluated according to the NIHA scale, and the prognosis is assessed according to the GRASE scale.

Examined was a group of 50 patients with true cardiogenic shock of different degrees of severity with a composition as follows: 49 cases with acute myocardium infarction, 1 case with aneurism rupture of Valsalva sinus. 48 males and 2 females were in the group.

13 patients had a repeated myocardial infarction, and 2 patients had a recurrent one. Considering the group, 29 patients had transmural myocardial infarction, 12 patients had large-focal myocardial infarction and 8 patients had a small-focal one.

All the patients were divided into 2 subgroups. The first subgroup consisted of 30 patients that died during different time periods after their admission to hospital. 14 of them died during the first 6 hours after the admission. Their middle age was 72±2,3 years. The III degree cardiogenic shock was observed in all patients. 7 patients died during the first 24 hours after their admission. Their middle age was 74,5±1,8 years. The III degree cardiogenic shock was observed in 5 patients, and the II degree cardiogenic shock was reported in 2 patients. 9 patients died on day 3 after their admission. Their middle age was 80,5±1,2 years. The III degree cardiogenic shock was recorded in 4 patients and the II degree cardiogenic shock was reported in 5 patients.

The second subgroup consisted of 20 patients with favorable outcome of the disease. Their middle age was 64±1,4 years. The III degree cardiogenic shock was observed in 1 patient, the II degree cardiogenic shock was reported in 16 patients, and the I degree cardiogenic shock was recorded in 3 patients. The systemic thrombolysis within intensive care system was received by 13

patients (9 patients with favorable outcome and 4 patients with lethal outcome). The rest of the patients did not receive thrombolysis due to their late admission or because of the presence of explicit contraindications. The examinations were carried out on days 1, 3, and 5 after admission and also under postmortem conditions immediately upon the death, considering the conducted medication therapy.

The results of the study show that, when considering an individual heart cycle, in case of a deviation or failure in a cardiac cycle phase, the next phase undertakes a compensation to improve or eliminate the deviation or the failure in the most adequate way. Such an interrelation between the phases determines the compensation mechanism of the phase performance of the heart and the blood vessels [9]. The phases responsible for the heart blood filling influence on the phases responsible for building up of the initial minimum and maximum arterial pressure, and vice versa. When identifying pathology it is important to detect the phase with the primary cause that leads to deviations in the other phases. 6-8 hours before the fatal arrhythmia, the following changes are observed: loss of the contractility function of the interventricular septum. The minimum R wave amplitude indicates it.

The S wave expansion is a marker of the compensatory function. As the myocardium muscle undertakes an increased contractility load, it expands in volume. An elevation of the S-L wave on ECG is found in case of an increase in arterial pressure. In this case it is a marker of a constant myocardium tension, since the S-L phase amplitude is located above the isoelectric line in each cardiac cycle.

Thus, the main mechanism of the heart performance control is the respective level of blood pressure in each phase of a cardiac cycle. The levels are interrelated with the respective phase volumes of blood, and their serious changes cause fatal disturbances in rhythmogenesis and trigger progression of fatal arrhythmias.

Results and conclusions

The investigations of the cardiac phase mechanism are being continued. The application of the system hemodynamic evaluation and the medication and infusion therapy supported by monitoring with the Cardiocode device allows reducing the mortality rate by 32 ± 3,4 %. Survival rate analysis by the Kaplan-Meier method is shown in Fig.1 below [10].

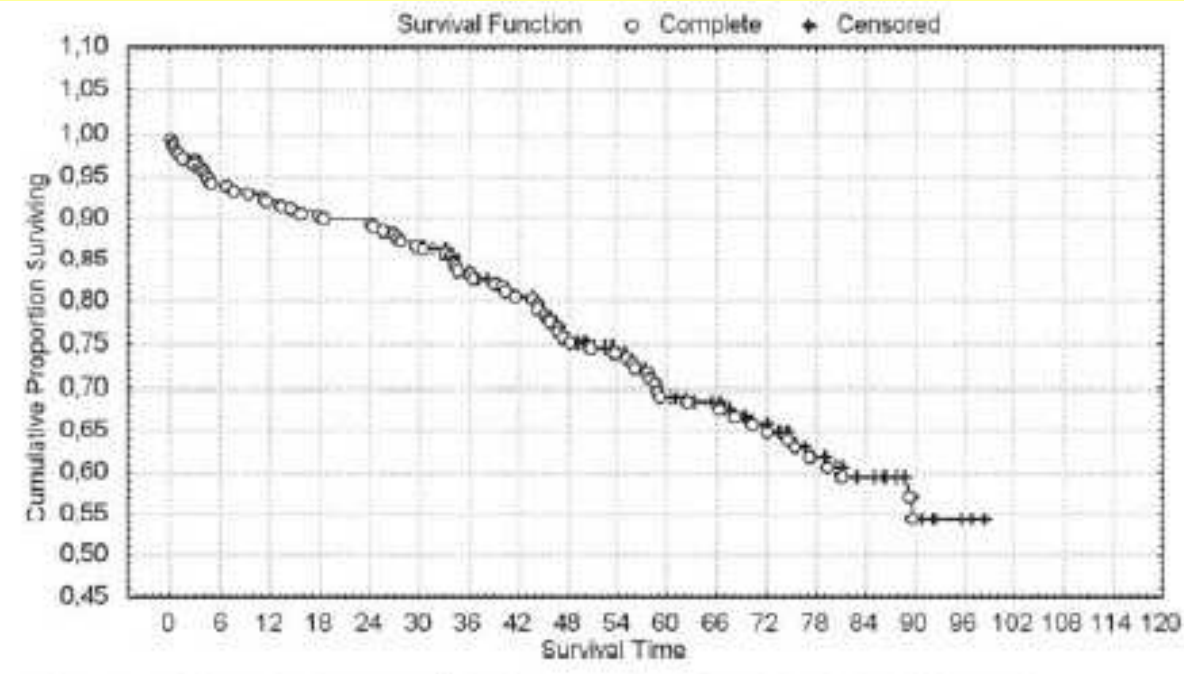


Figure 1. Survival rate analysis by Kaplan-Meier.

Statement on ethical issues

Research involving people and/or animals is in full compliance with current national and international ethical standards.

Conflict of interest

None declared.

Author contributions

The author read the ICMJE criteria for authorship and approved the final manuscript.

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