A Mobile System for the Hypertension Management in Remote Patients and Evaluation of the Risk Markers for Hypertension-Related Complications

Elena Andreeva*, Alexander Borodin†, Tatyana Kuznetsova†

*Petrozavodsk City Clinic 1, Petrozavodsk, Russia

†Petrozavodsk State University (PetrSU), Petrozavodsk, Russia

elena-andreeva00@mail.ru, aborod@cs.petrsu.ru, eme@sampo.ru

Abstract—Arterial hypertension is a significant multifactorial disease with a long treatment period. Treatment strategies include lifestyle changes and pharmacological therapy. both with medicines and non-drug therapy. The necessity of personal life changes leads to the low adherence to the treatment among the patients. In the proposed approach, the mobile personal monitoring system is used to address the problem of low adherence. The system provides both the assessment of the complication risk on the base of continuously monitored ECG parameters and the questionnaire for regular health status audit.

I. INTRODUCTION

Approximately 30–40% of a world population suffer from increased arterial pressure (arterial hypertension). According to the World Health Organization report, arterial hypertension is the most essential preventable risk factor of premature death [1]. Prevention and treatment of arterial hypertension heavily rely on behaviour change, moreover, for the majority of patients, a substantial modification of their lifestyle has prime significance [2]. Therefore, the therapy is time-consuming and it demands a self-discipline from the patient. It is shown that in a six months period more than a third, and in a year more than a half of the patients, stop the appointed treatment, and about 10% of the patients forget to accept medicines daily [3], [4]. Thus, there is a problem of low adherence of the hypertensive patients to prevention and treatment, i.e., of the readiness for strict observance of the instructions appointed by the doctor both at medicines intake and at the behaviour change (e.g., of the recommendations to intensify the physical activity, stick to a healthy eating plan, etc.)

The solution of this problem can be built on an integrated approach to hypertension management including the use of the background intellectual environment to supervise the patient by means of the systems of personal recommendations (intellectual assistants). Aforesaid integrated system belongs to the class of so-called personalized medicine systems. These systems are considered to be a promising way to open the adaptation opportunities of a human being and to increase the duration of his active life. Research and development initiatives in the area of personalized medicine are supported by governmental programs, in particular, they are stated as one of the priority directions that should be supported for increase of competitiveness and investment appeal of the Russian medical science [5]. From the other hand, personalized medicine demands support of mobility of the patient, realization of complex collecting and the analysis of personal data and a

context information, and also "smart" decisions on the basis of personalisation, a context, and recommendation systems [6]. Thus, the proposed solution is significantly banks on the use of the information technologies, and, in particular, on the recent advances in mobile healthcare, smart environments and cloud computing. This approach leads to minimization of risk of complications due to improvement of prevention, early diagnostics, forecasting of development of the disease.

In this work up to the 300 hypertensive patients were selected for control group. The examination included the natural history analysis, the assessment of usual risk factors, identification of subclinical asymptomatic organ damage (ultrasound scanning of carotid arteries, microalbuminuria, left ventricle hypertrophy, coronary calcium index), identification of cardiovascular or renal diseases, blood pressure variability between visits, adherence to treatment according to existing indexes and questionnaires.

II. ESTIMATION OF THE NEW COMPLICATION RISK MARKERS

There are a lot of possible ECG parameters that are considered to be the cardiovascular risk markers in recent researches. These parameters are studied insufficiently and their relation with development of arterial hypertension complications is not widely confirmed.

The following ECG parameters are planned to be monitored during the investigation: 1) heart rhythm disturbances such as arterial fibrillation, premature ventricular contraction and others; 2) heart blocks; 3) heart rate; 4) P wave duration; 5) P wave amplitude; 6) P wave morphology, in particular, two-phase shape; 7) PQ interval duration; 8) QT dispersion; 9) Q width; 10) R amplitude; 11) S amplitude; 12) QRS width; 13) QT duration; 14) T wave amplitude; 15) T wave alternation; 16) T wave width and "T peak – T end" parameter; 17) ST elevation; 18) ST decrease; 19) rhythm turbulence; 20) heart rate variability.

Moreover, during the monitoring, the patients will be able to record the results of independent measurements of the blood pressure. This will allow to evaluate the blood pressure variability depending on many factors (ECG parameters, drug schedule, day time, etc.) between visits to the clinic.

To increase the adherence the mobile app provides a questionnaire for the regular log of complaints and analysis

of their connections with hypertension and drug treatment. At the whole, the log gives the life quality assessment that defines the adherence of the patient to the treatment plan.

III. INCREASING THE ADHERENCE TO THE TREATMENT

The long terms of therapy together with the need of change of a lifestyle cause low adherence of the patients to arterial hypertension treatment. At the same time, development of technologies of the Internet of physical devices (IoT) promotes simplification of continuous collecting and analysis of health parameters of the patient and the auxiliary information characterizing his environment and a way of life, for making decision by the doctor on therapy change, and use of intellectual assistants—to stimulate and assess the adherence to the treatment. Emergence of similar technologies poses a number of research tasks on a joint of medicine and information technologies which are supposed to be solved within the project. Creation of the simplified questionnaire for the patient about a state of health for further technical realization in the form of the app for the mobile device for the purpose of information transfer in a convenient and available form via phone (complaints, their communication over time days, meal, physical activities, reception of tablets, etc.) is currently under development.

The following questions and possible answers are included to the questionnaire.

1) How do you estimate your health state? The possible answers are "excellent", "good", "satisfactory" and "bad".
2) Whether you had experienced headaches? The possible answers are "yes", "no" and "do not remember".
3) Whether you had experienced the chest pain or discomfort in heart? The possible answers are "yes", "no" and "do not remember".
4) Whether you had the interruptions in work of heart or heartbeat? The possible answers are "yes", "no" and "do not remember".
5) Whether you had experienced the difficulty breathing? The possible answers are "yes", "no" and "do not remember".
6) Whether the physical activity was interrupted in connection with an illness? The possible answers are "yes" and "no".
7) Whether you take your medications regularly? The possible answers are "yes" and "no".
8) Whether you had the sleep disorders owing to the illness? The possible answers are "yes" and "no".

The application will allow the patient to send the alarm notification in the emergency case. The purpose is to address to the doctor timely and obtain the further guideline (e.g., call the ambulance or to take medications independently). The following list of complaints is suggested for "the alarm button": 1) intensive headaches; 2) severe dizziness; 3) nausea or vomiting; 4) sharp violation of sight; 5) severe chest pain; 6) severe shortage of air; 7) another reason.

IV. CONCLUSION

In this work-in-progress report the mobile system for the decreasing of hypertension-related risk and addressing the low adherence problem is proposed.

REFERENCES

[1] World Health Organization report, "Global Health Risks. Mortality and burden of disease attributable to selected major risk", Web: http://www.who.int/healthinfo/global burden disease/GlobalHealthRisks-report full.pdf

[2] Recommendations of the European Society of Hypertension, Web: http://www.esh2013.org/wordpress/wp-content/uploads/2013/06/ESC-ESH-Guidelines-2013.pdf

[3] G. Corrao et. al."Cardiovascula protection by initial and subsequent combination of antihypertensive drugs in daily life practic", Hypertension, vol. 58, 2012, pp. 566–572.

[4] N. K. Gale et. al. "Patient and general practitioner attitudes to taking medication to prevent cardiovascular disease after receiving detailed information on risks and benefits of treatment: a qualitative study", BMC Family Practice, 2011.

[5] The order of the Government of the Russian Federation of December 28, 2012 of N 2580-p "About the confirmation of Strategy of development of medical science in the Russian Federation for the period till 2025", Web: http://www.rosminzdrav.ru/documents/5413-rasporyazhenie- pravitelstva-rossiyskoy-federatsii-ot-28-dekabrya-2012-g-n-2580-r.

[6] H. Demirkan, "A Smart Healthcare Systems Framework", IT Professional, vol.15, no. 5, 2013, pp. 38–45.