

## HEART RATE VARIABILITY IN PATIENTS WITH CHRONIC RENAL FAILURE

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**Summary:** This review shows that heart rate variability is an important method to estimate autonomic regulation of heart rate. There is a significant amount of researches on the impact of chronic renal failure on changes of heart rate variability. Heart rate variability changes arise because of the disruption of water and electrolyte balance, remodeling and fibrosis of the myocardium and activation of sympathetic or parasympathetic nervous system. Hemodialysis also increases the risk of life-dangerous arrhythmias.

**Key words:** Heart rate variability, chronic kidney disease, chronic renal failure.

Heart rate variability (HRV) - a variability of duration of RR intervals of successive heart rate cycles at regular intervals, expressed in ratio of fluctuations in heart rate (HR) to its average. A large number of studies of heart rate variability is held in the CIS [Iliyev V.M. et al., 2003; Bayevskiy R.M., Berseniyeva A.P., 1997], as well as all over the world. [Penttila J. et al., 2001; Malliani A., 1995; Coumel P. et al., 1995].

HRV is accepted as the most informative non-invasive method of quantitative estimating of heart rate autonomic regulation. HRV testing is one of the most powerful methods to control the humoral and autonomic nervous regulation in various areas of modern medicine. The most important among them are the syndrome of neuropathy that complicates the diseases and conditions such as renal failure, diabetes, hypertension, coronary heart disease, neurosurgical and neurological diseases, including traumatic brain injury.

Changes of HRV allow us to draw conclusions about the

appearance of life-dangerous arrhythmias. Besides the electrocardiography medic may use other methods to record heart rate cycles. [4] The most studied heart rate variability in patients with myocardial infarction, which time parameters of HRV are reduced.

It is found a clear correlation between the decreasing of heart rate variability and the increasing mortality during the ARIC (Atherosclerosis Risk In Communities) study. In 13 241 adult participants of ARIC Study heart rate variability at rest was examined. According to the Brotman DJ, Bash LD, Qayyum R. et al. the likelihood of the final stages of CKD in patients with lower heart rate variability is bigger in 1.56 times than the one in people with high variability [11]. This is because the heart rate variability reflects the condition of regulatory mechanisms, including tension of the autonomic nervous system and can be considered as a physiological regulation reserve [5], [1].

There's much attention is given to studies on the prognostic valuability of heart rate variability in determining the risk of sudden death and dangerous ventricular arrhythmias in patients with coronary heart disease [17], [10]. But the problem of electrical heart instability diagnosis in patients with chronic renal failure has been insufficiently studied yet [15].

Recently worldwide incidence of renal failure grows, which has as the main reasons hypertension, diabetic nephropathy and chronic glomerulonephritis. Unfortunately, chronic renal failure (CRF) is inevitably progressive condition [2].

One of the criteria for chronic kidney disease is glomerular filtration rate (GFR), which is in this state less than 60 ml / min per 1.73 m<sup>2</sup>. When reaching level of GFR less than 20 ml / min (blood creatinine level 0.5-0.6 mmol / l) patient should have the vascular access formed (arteriovenous fistula in the case of hemodialysis) or should be prepared for lifelong ambulatory peritoneal dialysis.

The main cause of death in patients with end-stage renal failure are cardiovascular complications. The level of mortality caused by these complications in patients with end-stage renal failure is 20 times

higher than the one in the general population [7]. Some patients with end-stage renal failure have a lack of hypertension correction, anemia and secondary hyperparathyroidism, which contributes to vascular calcification. All this leads to remodeling of the heart and blood vessels and the early development of heart failure and deadly arrhythmias [6].

Many patients with cardiovascular pathology have Long QT Syndrome (LQTS) detected. Often this syndrome appears as polymorphic ventricular tachycardia type "pirouette" and as sudden coronary death. LQTS can be observed during the hemodialysis manipulation [14].

Changes in heart rate variability after hemodialysis indicate the effect of hemodialysis on the heart rate regulation, that may be associated with significant changes in the homeostasis of the internal environment, such as circulating plasma volume and electrolyte levels [3]. In some studies researchers mentioned the connection of change of potassium levels after dialysis with heart rate variability indicators [16].

According to the research of Felix Ciovescu et al., 2014 intradialytic arrhythmias are widespread. Hemodialysis increases serum calcium level and increases acidosis. Increasing blood calcium level as well as unmodified serum calcium during hemodialysis lead to high-risk intradialytic ventricular extrasystoles. Postdialytic worsening of metabolic acidosis is associated with atrial fibrillation [12].

At the risk of heart failure and fatal arrhythmias is noticed prognostic significance of heart rate variability analysis [3]. In studies are shown changes of HRV in patients with different pathologies: diabetes, heart failure, hypertension, myocardial infarction. In patients with end-stage renal failure on hemodialysis is mostly sympatheticotonia found and overall heart rate variability reduced [13].

H.H. Shugushev et al. found that during hemodialysis takes place activation of the autonomic nervous system with a dominance of parasympathetic influence on the heart and decreasing sympathetic influence. The connection between changes in heart rate variability and the occurrence of dangerous arrhythmias is found [9]. However, data on

the activity of the autonomic nervous system are inconsistent. In the pathogenesis of chronic renal failure activation of the sympathetic nervous system takes important part. It's proved that increased sympathetic activity can be found at the time of functional impairment and does not depend on the type of kidney damage, also it promotes the development of nephropathy in two ways: due to increased proliferative processes and due to high blood pressure [2].

It is proved that in patients with end-stage chronic kidney disease is found change of heart rate variability because of remodeling and fibrosis of myocardium and death of cardiomyocytes.

The most dangerous affection of the cardiovascular system in patients on hemodialysis are arrhythmias because they often cause sudden death in patients with chronic kidney disease [8]. Because of this appears great importance of searching precursors of vitally-dangerous rhythm disturbances, their reasons and mechanisms of development. Very important is also a study of the opportunities for in-time correction of treatment for these patients.

## REFERENCES

1. Айдаралиев А.А. Адаптация человека к экстремальным условиям: опыт прогнозирования. / А.А. Айдаралиев., А.Л. Максимов // Л.: Наука, 1988. – 126 с.
2. Бахметьева Е.А. Повышение эффективности комплексной терапии хронической почечной недостаточности на основе разработки модели вегетативного статуса : автореферат дис. кандидата медицинских наук / Бахметьева Елена Алексеевна // [Место защиты: Воронеж. гос. техн. ун-т].- Воронеж, 2007.- 19 с.
3. Бунова С.С. Вариабельность сердечного ритма у больных на программном гемодиализе: гендерные различия./ С.С. Бунова, Л.В. Михайлова, О.А. Билевич и др. // Нефрология и диализ. Том 14, №3 2012г. стр. 170-173.

4. Котельников С.А. Вариабельность ритма сердца: представления о механизмах / С.А. Котельников, А.Д. Ноздрачев, М.М. Одинак и др. // Физиология человека. 2002. Т. 28, № 1. С. 130–143.
5. Кудій Л.І. Вариабельність серцевого ритму в осіб з різною частотою дихання: автореферат дис. кандидата мед. наук. // Л.І. Кудій, Київ, 2006, 20с.
6. Сторожаков Г.И. Поражение сердечно-сосудистой системы при хронической почечной недостаточности / Г.И. Сторожаков, Г.Е. Гендлин, Н.А. Томилина и др. // Рос. мед. журн. 2005. № 3. С. 4–8.
7. Томилина Н.А. Проблема сердечно-сосудистых заболеваний при хронической почечной недостаточности / Н.А. Томилина, Г.В. Волгина, Б.Т. Бибков и др. // Нефрология и диализ. 2003. Т. 5. № 1. С. 15–24.
8. Шугушев Х.Х. Сердечно-сосудистая система и хроническая болезнь почек. / Х.Х. Шугушев, Ф.М. Багова, М.Ж. Аттаева //Архивъ внутренней медицины. 2012г. №2(4). С. 56-59.
9. Шугушев Х.Х. Показатели variability ритма и аритмии сердца у больных с терминальной стадией хронической почечной недостаточности, находящихся на программном гемодиализе / Х.Х. Шугушев, М.М. Хамизова, В.М. Василенко и др. // Рос. кардиол. журн. 2003. Т. 4, № 42. С. 32–35.
10. Billman GE. Heart Rate Variability – A Historical Perspective. // *Frontiers in Physiology*. 2011;2:86. doi:10.3389/fphys.2011.00086.
11. Brotman D.J. Heart Rate Variability Predicts ESRD and CKD-Related Hospitalization / D.J. Brotman, L.D. Bash, R. Qayyum et al. // *J. Am. Soc. Nephrol.* 2010. Vol. 21, № 9. P. 1560–1570.
12. Ciovescu F. Haemodialysis-induced electrolyte variation (serum calcium, magnesium and bicarbonate) and intradialytic heart rhythm disorders. / F. Ciovescu, Ş.C. Vesa, D. Rădulescu, et al. // *HVM Bioflux* 2014; 6(1):11-14.

13. Maule S. Autonomic neuropathy and QT interval in hemodialysed patients / S/ Maule, M. Veglio, F. Mecco et al. // Clin. Auton. Res. 2004. Vol. 14. P. 233–239.
14. Shamseddin K. Sudden cardiac death in chronic kidney disease: epidemiology and prevention Nature Reviews / K. Shamseddin, P.S. Parfrey // Nephrology. 2011. № 7. P. 145–154.
15. Rubinger D. Sympathetic Nervous System Function and Dysfunction in Chronic Hemodialysis Patients. / D. Rubinger, R. Backenroth and D. Sapoznikov // Seminars in Dialysis, 26: 333–343. doi: 10.1111/sdi.12093
16. Wen T.L. Relationship between electrolytes and heart rate variability parameters in end-stage renal failure patients before and after hemodialysis / T.L. Wen, W. Chung-Kwe, I.F. Yang et al. // Anatol. J. Cardiol. 2007. Vol. 7. Suppl 1. P. 142–144.
17. Appel M.L. Beat to beat variability in cardiovascular variables: Noise or music? / M.L. Appel, R.D. Berger, J.P. Saul et al. // J. Am. Coll Cardiol. -1989. -V. 14. - P. 1139-1148.

## РЕЗЮМЕ

### **ВАРІАБЕЛЬНІСТЬ СЕРЦЕВОГО РИТМУ У ХВОРИХ З ХРОНІЧНОЮ НИРКОВОЮ НЕДОСТАТНІСТЮ**

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У даному огляді літератури показано, що варіабельність серцевого ритму являється важливим методом оцінки вегетативної регуляції серцевого ритму. Існує значна кількість наукових досліджень щодо впливу хронічної ниркової недостатності на зміни варіабельності серцевого ритму. Зміни ВСР виникають через порушення водно-електролітного балансу, ремоделювання та фіброз міокарду і активацію (за результатами різних досліджень) симпа-

тичної або парасимпатичної нервових систем. Гемодіаліз також підвищує ризик виникнення життєво-небезпечних аритмій.

**Ключові слова:** Варіабельність серцевого ритму, хронічна хвороба нирок, хронічна ниркова недостатність.

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### **ВАРИАБЕЛЬНОСТЬ СЕРДЕЧНОГО РИТМА У БОЛЬНЫХ С ХРОНИЧЕСКОЙ ПОЧЕЧНОЙ НЕДОСТАТОЧНОСТЬЮ**

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**Резюме.** В данном обзоре литературы показано, что вариабельность сердечного ритма является важным методом оценки вегетативной регуляции сердечного ритма. Существует значительное количество научных исследований о влиянии хронической почечной недостаточности на изменение вариабельности сердечного ритма. Изменения ВСР возникают из-за нарушения водно-электролитного баланса, ремоделирования и фиброза миокарда и преобладания (по результатам различных исследований) симпатической либо парасимпатической нервных систем. Гемодиализ также повышает риск возникновения жизненно-опасных аритмий.

**Ключевые слова:** Вариабельность сердечного ритма, хроническая болезнь почек, хроническая почечная недостаточность.