V.V. Rodionova,
O.O. Boiko

RENAL FUNCTION AND NUTRITIONAL STATUS IN PATIENTS WITH ARTERIAL HYPERTENSION

SE «Dnipropetrovsk medical academy of Health Ministry of Ukraine»
Department of occupational diseases and clinical immunology
V. Vernadsky str., 9, Dnipro, 49044, Ukraine
ДЗ «Дніпропетровська медична академія МОЗ України»
кафедра професійних хвороб та клінічної імунології
(зав. – д. мед. н., проф. К.Ю. Гашинова)
вул. В. Вернадського, 9, Дніпро, 49044, Україна;
e-mail: Olhashev93@gmail.com

Abstract. Renal function and nutritional status in patients with arterial hypertension. Rodionova V.V., Boiko O.O. *Arterial hypertension is the main preventable cause of cardiovascular disease and all causes of death worldwide, and also ranks second among the most important causes of chronic kidney disease after diabetes. An important factor contributing to the increase in blood pressure is obesity. Being overweight raises blood pressure and accounts for 65-75% of the initial hypertension, which is the main cause of cardiovascular disease and kidney disease. The aim of the work was to study renal function in patients with arterial hypertension, depending on the nutritional status of patients. Materials and methods. A prospective study included 47 stable outpatients with stage II arterial hypertension (left ventricular hypertrophy) of the 1st to 3rd degree, (24 women and 23 men), the average age was 55.7 (8.9) years. The mean disease duration was 14 (3.2) years. The control group included 28 relatively healthy people without arterial hypertension (15 women and 9 men), the average age was 56.0 (6.6) years. All patients were evaluated for complaints, medical history, smoking status, physical examination with anthropometric indicators (height, weight, body mass index, waist circumference), heart rate and blood pressure. The risk of cardiovascular events was also determined in accordance with the SCORE scale. The nutritional status was evaluated based on bioimpedancemetry data (Omron analyzer) with determination of the percentage of total fat, muscle mass and visceral fat. To determine the functional state of the kidneys, the level of total protein in blood serum, creatinine and albumin in the urine was determined, with the determination of the albumin creatinine ratio in a single portion of urine, the glomerular filtration rate were calculated. Results and conclusions. In patients with arterial hypertension, a change in nutritional status was detected in the form of an increase in the amount of total adipose tissue against a background of a decrease in muscle tissue pool, with the development of sarcopenia in combination with obesity. Also, patients developed hypertensive nephropathy. It was found that the BMI is not informative enough to determine nutritional status, but requires the use of bioimpedancemetry to determine the percentage of total fat, visceral fat and muscle mass.*

Реферат. Функція нирок і нутритивний статус у хворих на артеріальну гіпертензію. Родіонова В.В., Бойко О.О. *Артеріальна гіпертензія є основною запобіжною причиною, яка упереджується при серцево-судинних захворюваннях і всіх причинах смерті в усьому світі та посідає друге місце серед найбільш важливих причин хронічної хвороби нирок після діабету. Важливим фактором, що сприяє підвищенню артеріального тиску, є ожиріння. Надмірна вага сприяє підвищенню кров'яного тиску і становить 65-75% первинної гіпертонії, яка є основною причиною серцево-судинних захворювань і захворювань нирок. Метою роботи було дослідження функції нирок у хворих на артеріальну гіпертензію залежно від нутритивного статусу пацієнтів. Матеріали та методи. У проспективне дослідження увійшли 47 стабільних амбулаторних пацієнтів з артеріальною гіпертензією II стадії (гіпертрофія лівого шлуночка) 1-3 ступеня, (24 жінки і 23 чоловіки), середній вік – 55,7 (8,9) року. Середня тривалість захворювання становила 14 (3,2) років. До контрольної групи були включені 28 відносно здорових осіб без артеріальної гіпертензії (15 жінок і 9 чоловіків), середній вік – 56,0 (6,6) років. Усім пацієнтам проводили оцінку скарг, анамнестичних даних, статусу куріння, фізикальний огляд з визначенням антропометричних показників (зріст, вага, індекс маси тіла, окружність талії), вимірюванням*

частоти серцевих скорочень і рівня артеріального тиску. Також визначали ризик серцево-судинних подій відповідно до шкали SCORE. Стан нутритивного статусу оцінювали на підставі даних біоімпедансметрії (аналізатор "Omron") з визначенням відсотка загального жиру, м'язової маси і вісцерального жиру. Для уточнення функціонального стану нирок визначали рівень загального білка в сироватці крові, креатиніну та альбуміну в сечі, з визначенням альбумін-креатиніну співвідношення в разовій порції сечі, обчислювали швидкість клубочкової фільтрації. Результати та висновки. У пацієнтів з артеріальною гіпертензією було виявлено зміну нутритивного статусу у вигляді підвищення кількості загальної жирової тканини на тлі зниження пулу м'язової тканини, з розвитком саркопенії в поєднанні з ожирінням. Також у пацієнтів мало місце формування гіпертензійної нефропатії. Було виявлено, що показник ІМТ не є достатньо інформативним для визначення нутритивного статусу, що вимагає застосування методу біоімпедансметрії для визначення відсотка загального та вісцерального жиру, м'язової маси.

Substantial progress has been made in understanding the epidemiology, pathophysiology, and risk associated with hypertension, and a wealth of evidence exists to demonstrate that lowering blood pressure (BP) can substantially reduce premature morbidity and mortality. A number of proven, highly effective, and well-tolerated lifestyle and drug treatment strategies can achieve this reduction in BP. Despite this, BP control rates remain poor worldwide and are far from satisfactory across Europe. Consequently, hypertension remains the major preventable cause of cardiovascular disease (CVD) and all-cause death globally and in our continent [3, 15]. Hypertension is the second most important cause of chronic kidneys diseases (CKD) after diabetes. Hypertension may also be the presenting feature of asymptomatic primary renal disease. An alteration of renal function is most commonly detected by an increase in serum creatinine. This is an insensitive marker of renal impairment because a major reduction in renal function is needed before serum creatinine rises, however, in the early stages, this indicator is not effective enough [14]. An important factor contributing to the increase in blood pressure is obesity. Excessive adiposity raises blood pressure and accounts for 65-75% of primary hypertension, which is a major driver of cardiovascular and kidney diseases. In obesity, the incidence of hypertension directly correlates with an increase in body mass index (BMI). Hypertension, high normal blood pressure and "white coat hypertension" occur with high frequency in obesity and are often associated with increased waist circumference and insulin resistance. According to the Framingham study, an increase in weight of 1 kg helps to increase blood pressure by 1 mmHg. [7]. In obesity, abnormal kidney function and associated increases in tubular sodium reabsorption initiate hypertension, which is often mild before the development of target organ injury. Factors that contribute to increased sodium reabsorption in obesity include kidney compression by visceral, perirenal and renal sinus fat; increased renal sympathetic nerve activity (RSNA); increased

levels of anti-natriuretic hormones, such as angiotensin II and aldosterone; and adipokines, particularly leptin. The renal and neurohormonal pathways of obesity and hypertension are intertwined. For example, leptin increases RSNA by stimulating the central nervous system proopiomelanocortin–melanocortin 4 receptor pathway, and kidney compression and RSNA contribute to renin–angiotensin–aldosterone system activation. Glucocorticoids and/or oxidative stress may also contribute to mineralocorticoid receptor activation in obesity. Prolonged obesity and progressive renal injury often lead to the development of treatment-resistant hypertension. Patient management therefore often requires multiple antihypertensive drugs and concurrent treatment of dyslipidaemia and inflammation [11, 14].

The aim of the study: to determine of renal function in patients with arterial hypertension, depending on the nutritional status of patients.

MATERIALS AND METHODS OF RESEARCH

The retrospective part of the study included 75 patients with hypertension. Criteria for inclusion in the study: verified diagnosis of arterial hypertension. The diagnosis of hypertension was verified on the basis of recommendations for the management of arterial hypertension of the European Society of Cardiology and the European Society for Arterial Hypertension, 2018 [15].

Exclusion criteria were: patients over 80 years old, history of acute cardiovascular events, heart failure with systolic dysfunction, coronary heart disease, clinically significant heart rhythm disturbances, diabetes, kidney diseases, surgery over the past year and oncological diseases.

A prospective study, after careful selection based on inclusion and exclusion criteria, included 47 stable outpatients with stage II arterial hypertension (left ventricular hypertrophy) of the 1st to 3rd degree (24 women and 23 men), the average age was 55.7 (8.9) years. The mean duration of hypertension was 14 (3.2) years. The control group included 28 relatively healthy individuals without arterial hypertension (15 women and 9 men), the average age was 56.0 (6.6) years. By age and gender, both groups

were statistically comparable and did not have a significant difference (p≥0.05) [1, 4].

Patients with arterial hypertension were treated according to the recommendations for the management of arterial hypertension of the European Society of Cardiology and the European Society of Arterial Hypertension, 2018 [15]. Patients had an average adherence to treatment.

The general clinical examination included the assessment of complaints, medical history, smoking status, physical examination with determination of anthropometric parameters (height, weight, BMI, waist circumference), measurement of heart rate (HR) and blood pressure level: systolic blood pressure(SBP) and diastolic blood pressure (DBP). Cardiovascular risk according to the SCORE scale was calculated for all patients [15]. All patients underwent bioimpedancemetry (Omron analyzer) to determine the percentage of total fat, muscle mass and visceral fat. The data obtained were compared with reference values [2]. The levels of total cholesterol(TH), triglycerides (TG), low density lipoproteins (LDL), very low density lipoproteins (VLDL), high density lipoproteins (HDL), and atherogenicity coefficient (AC) were investigated. The level of creatinine and albumin in the urine were determined, with the calculation of the albumin-urine creatinine ratio (ACR) in a single portion of urine to determine the kidney function. Glomerular filtration rate (GFR) was calculated using the formula CKD-EPI (Chronic Kidney Desease Epi-

demiology Collaboration). To clarify the diagnosis, patients underwent ultrasound of the heart, electrocardiographic examination, ultrasound of the abdominal organs. The results were processed using the program Statistica v. 6.1 (Statsoft Inc., USA) (license number AGAR909E415822FA) with determination of mean values (M), standard deviation (SD) in the case of normal distribution of values, and median (Me), upper and lower quartiles ([25%; 75%]) in the case of non-normal distribution. Parametric methods were used with help of Student's t-test in the case of a normal distribution of values. For a distribution other than normal, the nonparametric Mann-Whitney test was used. The probability of an error-free forecast of qualitative signs was carried out using the Xi-square test ($x2$). For correlation analysis, we used the Pearson parametric method or the Spearman nonparametric method with the determination of the correlation coefficient (R). When analyzing the data, the differences between the groups were considered significant at $p<0.05$ [1, 4].

RESULTS AND DISCUSSION

The examined patients of both groups were comparable in age and gender composition. In the hypertensive group there were 15 of 47 smoking patients, in the comparison group – 7 of 28. Both groups were comparable in the number of smokers. (p≥0.05). The data of the physical examination of patients are presented in table 1.

Table 1

Physical examination of patients

Definition	Main group	Control group	p
Age, y M(SD)	55.7 (8.9)	56.0 (6.6)	0.8
Pack / year index M(SD)	20.0 (8.1)	27.8 (10.7)	0.16
SBP, mmHg Me [25%-75%]	135.5 (132.2-140.0)	127.2 (127.2-130.0)	0.001
DBP, mmHg Me [25%-75%]	84.2 (81.0-90.0)	83.5(80.0-83.5)	0.001
Heart rate, in 1 min M(SD)	86.4(8.1)	74.8 (4.5)	0.002

Patients of the hypertension group complained of periodic heart palpitations, headache, and increased blood pressure. Levels of SBP, DBP and heart rate in patients in the main group were significantly higher than in patients in the control group. According to the SCORE scale, 51.7% (n=15) of pa-

tients had an average risk of developing cardiovascular complications, 31.0% (n=9) of patients had a high risk, and 17.3% (n=5) of a very high risk.

The nutritional status of patients was determined using anthropometry and bioimpedancemetry (table 2).

Table 2

Indicators of nutritional status in the examined patients

Definition	Main group	Control group	p
Body weight, Me [25%-75%]	90.4(77.9-103.0)	87.5 (76.8-95.0)	0.7
BMI, Me [25%-75%]	30.0(25.9-33.4)	27.8(24.6-31.5)	0.9
Total fat, % Me [25%-75%]	36.3(32.8- 40.2)	22.3(22.0-22.5)	<0.0001
Muscle, %Me [25%-75%]	27.4(25.0-28.7)	35.0 (34.0-35.3)	<0.0001
Visceral fat, % Me [25%-75%]	11.9 (9.0-14.0)	10.0 (9.5-10.7)	0.07
Waist circumference , sm M(SD)	94.5 (1.5)	90.5 (1.3)	0.06

It should be noted that, despite a slight difference in BMI in patients of both groups, there was a predominance of average body weight in patients with hypertension due to a statistically significant increase in total fat against a significant decrease in muscle tissue. The data obtained corresponds to that given in the work of Satardinova E.E. [7], in that the prevalence of body mass deficiency among patients without arterial hypertension is significantly lower than in patients with arterial hypertension. There is also a decrease in muscle mass in patients with hypertension due to the development of sarcopenia [8]. The most unfavorable metabolic aspect of sarcopenia is considered the combination of sarcopenia with obesity, since this tandem significantly increases the risk of death and is often found in male patients [13]. It is believed that an increase in the mass of total or visceral adipose tissue leads to an increase in the secretion of pro-inflammatory cytokines and an imbalance in the adipokine-myokine-osteokine system, which ultimately leads to atrophy of bones and muscles, a decrease in physical activity and further progression of obesity. Sarcopenia is directly related to osteopenia and osteoporosis, which allowed a number of authors to propose the term "osteosarcopenic obesity" [8, 13]. Sarcopenia and obesity have a mutually aggravating effect: sarcopenia leads to a decrease in physical activity and, as a result, to an increase in fat mass, and the development of obesity, in turn, is accompanied by an increase in the production of proinflammatory cytokines, dysregulation of the secretion of leptin and adiponectin, and a decrease in muscle sensitivity to insulin, which contributes to further exacerbation of sarcopenia [5]. In patients of an older age group with arterial hypertension, a decrease in overall motor activity is significantly more likely to occur compared with patients without arterial hypertension [13].

Analyzing the data of a laboratory study of blood serum and urine (table 3), it was noted that the level of creatinine and albumin in the urine was significantly higher in the main group. An increase in urine creatinine may be associated with the development of renal hyperfiltration against the background of an increase in blood pressure, mainly SBP, which is consistent with data obtained in studies of E. Lopina. et al. [2], who noted an increase in urinary creatinine levels with elevated levels of SBP. In patients with hypertension, the ACR in the urine was also significantly higher, and the GFR indicator was significantly lower compared with the control group. According to the HOPE study, an increased urine albumin / urine creatinine ratio is a predictor of the development of severe complications: stroke, myocardial infarction, death from cardiovascular complications. The growth of this indicator for every 0.4 mg/mmol above normal increases the risk of cardiovascular complications by 5.9% [2].

A decrease in GFR below 90 ml/min. was also observed in patients of the control group, which is consistent with the idea of a physiological decrease in renal function in older patients [4].

The data obtained suggest that in patients with stage II arterial hypertension, hypertensive nephropathy is formed with initial manifestations of impaired renal function. According to the European Society of Arterial Hypertension [6], the development of chronic kidney disease in its early stages contributes to an increase in the level of cardiovascular risk and the likelihood of mortality. A significant increase in blood LDL and TG levels in patients with hypertension, combined with obesity and decreased kidney function, can increase the risk of fatal cardiovascular events in this category of patients (table 3).

Data of laboratory tests of blood and urine

Definition	Main group	Control group	p
Total cholesterol, μmol/l M(SD)	4. 9 (0.7)	4.6 (0.8)	0.06
LDL, μmol/l Me [25 %-75 %]	2.7 (2.3-3.8)	2.1(1.8-3.0)	0.04
VLDL, μmol/l Me [25 %-75 %]	0.5 (0.5-0.8)	0.5(0.4-0.7)	0.2
HDL, μmol/l Me [25 %-75 %]	0.9(0.8-1.2)	1.1(1.0-1.2)	0.2
TG, μmol/l Me [25 %-75 %]	1.7 (1.3-2.4)	1.4 (0.9-1.8)	0.04
AC Me [25 %-75 %]	2.9 (2.1-4.2)	2.7 (2.0-3.2)	0.2
Blood creatinine, μmol / l M(SD)	93.87(7.7)	85.4 (8.7)	0.04
GFR, ml/min Me [25 %-75 %]	72.0 (62.5-82.1)	82.0 (74.2-93.0)	0.01
Urinary creatinine, mcmol/L M(SD)	5423. 6 (495.8)	1078.4 (551.6)	0.002
Urine albumin, mg/mmol M(SD)	15.3(2.1)	8.8(2.)	0.05
ACR Me [25 %-75 %]	13.0(6.2-13.0)	9.3(2.0-9.3)	0.007

Based on the data of the correlation analysis, the relationship between the state of nutritional status in patients with hypertension and the functional state of the kidneys is determined. In the control group, between the indicators of adipose tissue content and the level of urinary albumin excretion, a positive relationship of medium strength was revealed. R=0.5 (p=0.03), that is an increase in total fat may contribute to impaired renal function. In patients of the main group, a combination of several mutually aggravating factors (hypertension, obesity, dyslipidemia, etc.) leads to a significant aggravation of renal dysfunction, which probably leads to a transition from microalbuminuria to excretion of large protein molecules in the urine [2]. Thus, a negative correlation relationship of medium strength R= -0.46 (p=0.04) was found between the content of adipose tissue and the level of urinary albumin excretion. Similar violations can be associated with a change in the functioning of adipose tissue itself. Thus, white adipose tissue is not only a simple organ for storing fat, but is currently regarded as a dynamic tissue involved in the production of a number of adipokines, such as leptin, adiponectin, tumor necrosis factor-α (TNF-α), monocyte chemotactic protein-1 (MCP-1) Transforming Growth Factor-Beta (TGF-β) and Angiotensin II. The balance between these adipokines allows adipose tissue to regulate appetite, food intake, glucose excretion and energy expenditure. Violation of this balance in obesity contributes to the formation of a pro-inflammatory environment and causes the development of insulin resistance (IR). According to Declèves AE, Sharma K. [10], an increase in adipose tissue (obesity) contributes to the development of kidney pathology due to impaired renal hemodynamics, endothelial and podocyte dysfunction, thickening of the glomerular basement membrane and expansion of the mesangial canal, tubular atrophy, interstitial fibrosis. Morphological changes lead to a progressive decrease in renal function – the development of microalbuminuria, proteinuria and a decrease in GFR, which, in the end, is characterized by the development of the terminal stage of renal failure (ESR). Thus, a vicious circle of pathological changes arises – the appearance of hypertension and a change in nutritional status leads to impaired renal function, which, in turn, contributes to the aggravation of hypertension syndrome and is confirmed by the identification of the examined patients with arterial hypertension a negative correlation between GFR and the level of SBP R= -0.5 (p=0.02) and a positive strong correlation between the level of DAT and albuminuria R=0.6 (p=0.03).

CONCLUSIONS

1. Patients with arterial hypertension showed a change in nutritional status in the form of a significant increase in the amount of total adipose tissue against a background of decreased muscle tissue, with the development of metabolically unfavorable sarcopenia in combination with obesity.

2. In patients with initial manifestations of impaired renal function hypertensive nephropathy develops. A significant increase in LDL and TG levels in patients with hypertension combined with obesity and decreased kidney function can increase the risk of fatal cardiovascular events.

3. All patients with hypertension should not only undergo an anthropometric study to determine BMI, but bio-impedancemetry to determine the total fat, muscle mass and visceral fat as well.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Antomonov MYu. [Mathematical processing and analysis of biomedical data]. MITC "Medinform". 2018;2:579. Russian.

2. Antoshchenko PA. [Features of change of the speed of club filtration in persons of an older age with physiological and pathological type of aging]. International Student Scientific Herald. 2016;6. Russian. Available from: https://www.eduherald.ru/pdf/2016/6/16662.pdf

3. Goropko OYu. [Obesity and hypertension: current views on pathogenesis, diagnosis and treatment]. Family medicine. 2019;2:1824. Russian. Available from: http://familymedicine.com.ua/article/view/174626

4. Lang TA, Sesik M. [How to describe statistics in medicine. Guide for authors, editors and reviewers. Practical Medicine]. 2011;47-49;65-77;93-95. Russian

5. Lopina EA. [Estimation of indicators of the kidney function in patients suffering with arterial hypertension and abdominal obesity, suffered from acute society under security]. Almanac of Clinical Medicine. 2016;44(3):301-7. Russian. doi: https://doi.org/10.18786/2072-0505-2016-44-3-301-307

6. Rodionova VV, Boyko OO, Turenko OA, Denisenko OO. [Predictors of chronic heart failure development and progression in pre-dialysis patients with chronic kidney disease]. Kidneys. 2019;8(1):29-33. Ukrainian. doi: https://doi.org/10.22141/2307-1257.8.1.2019.157793

7. Satardinova EE, Olenskaya TL. [Relationship of the syndrome of malnutrice and sarcopenia in patients with arterial hypertension]. Modern problems of science and education. 2017;3. Russian. Available from: http://www.science-education.ru/ru/article/view?id=26354

8. Smirnov AV, Golubev RV, Korosteleva NY, Rumyantsev AS. [Decline of physical performance in patients receiving renal replacement therapy: focus on sarcopenia]. Nephrology (Saint-Petersburg). 2017;21(4):9-29. Russian. doi: https://doi.org/10.24884/1561-6274-2017-21-4-9-29

9. Glinyanaya LA, Rodionova VV, Gashynova KY, et al. [Analysis of the activities of the city center of occupational diseases treatment on the basis of the Communal Enterprise "Dnipropetrovsk City Multiprofile Clinical Hospital N 4" DRC" and some aspects of the experience of cooperation with the Fund of Social Insurance against Industrial Accidents and Occupational Diseases of Ukraine in the city Dnepr]. Medicni perspectivi. 2017;3:40-47. Ukrainian. doi: https://doi.org/10.26641/2307-0404.2018.3(part1).142335

10. Declèves AE, Sharma K. Obesity and kidney disease: differential effects of obesity on adipose tissue and kidney inflammation and fibrosis. Curr Opin Nephrol Hypertens. 2015 Jan;24(1):28-36. doi: https://doi.org/10.1097/MNH.0000000000000087. PMID: 25470014; PMCID: PMC4847436.

11. Hall JE, do Carmo JM, da Silva AA, et al. Obesity, kidney dysfunction and hypertension: mechanistic links. Nat. Rev. Nephrol. 2019;15:367-85 doi: https://doi.org/10.1038/s41581-019-0145-4

12. Apovian CM, et al. Pharmacological management of obesity: an endocrine society clinical practice guideline; 2015. doi: https://doi.org/10.1210/jc.2014-3415

13. Tian S, Xu Y. Association of sarcopenic obesity with the risk of all-cause mortality: a meta-analysis of prospective cohort studies. Geriatr Gerontol Int. 2016;169(2):155-66. doi: https://doi.org/10.1186/s12877-019-1195-y

14. Williams B, Mancia G, Spiering W, Agabiti Rosei A, Azizi M, Burnier M, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. J Hypertens. 2018; 36:1953-2041. doi: https://doi.org/10.1097/HJH.0000000000001940

15. 2018/ESH Guidelines for the management of arterial hypertension: The Task Force for the management of arterial hypertension of the European Society of Cardiology (ESC) and the European Society of Hypertension (ESH). European Heart Journal. 2018;39(33):3004-21. doi: https://doi.org/10.1093/eurheartj/ehy339

СПИСОК ЛІТЕРАТУРИ

1. Антомонов М. Ю. Математическая обработка и анализ медико-биологических данных. Киев: МИЦ «Мединформ», 2018. 2-е изд. 579 с.

2. Антощенко П. А. Особенности изменения скорости клубочковой фильтрации у лиц старшего возраста с физиологическим и патологическим типом старения. *Междунар. студ. научный вестник.* 2016. № 6. URL: http://www.eduherald.ru/ru/article/view?id=16662

3. Горопко О. Ю. Ожирение и артериальная гипертензия: современные взгляды на патогенез, диагностику и лечение. *Семейная медицина.* 2019. № 2. С. 18-24. URL: http://family-medicine.com.ua/article/view/174626

4. Ланг Т. А., Сесик М. Как описывать статистику в медицине: рук-во для авторов, редакторов и рецензентов. Практ. Медицина. 2011. С. 47-49;65-77;93-95.

5. Лопина Е. А. Оценка показателей функции почек у пациентов, страдающих артериальной гипертонией и абдоминальным ожирением, перенесших острое нарушение мозгового кровообращения, в зависимости от целевого уровня систолического артериального давления в восстановительном периоде инсульта. *Альманах клинической медицины*. 2016. Т.44, № 3. С. 301-307.
DOI: https://doi.org/10.18786/2072-0505-2016-44-3-301-307

6. Родіонова В. В., Бойко О. О., Туренко О. А., Денисенко О. О. Предиктори розвитку і прогресування серцевої недостатності в додіалізних хворих із хронічною хворобою нирок. *Нирки*. 2019. № 1. С. 29-33.
DOI: https://doi.org/10.22141/2307-1257.8.1.2019.157793

7. Сатардинова Э.Е., Оленская Т.Л. Взаимосвязь синдрома мальнутриции и саркопении у пациентов с артериальной гипертензией. *Современные проблемы науки и образования*. 2017. № 3. URL: www.science-education.ru/ru/article/view?id=26354

8. Смирнов А. В., Голубев Р. В., Коростелева Н.Ю., Румянцев А. Ш. Снижение физической работоспособности у больных, получающих заместительную почечную терапию: фокус на саркопению. *Нефрология*. 2017. Т. 21, № 4. С. 9-29.
DOI: https://doi.org/10.24884/1561-6274-2017-21-4-9-29

9. Структура промислово зумовлених захворювань у робітників металургійного підприємства, які працюююють у шкідливих умовах / Л. А. Глиняна та ін. *Медичні перспективи*. 2018. № 3. Ч. 1. С. 60-64.
DOI: //doi.org/10.26641/2307-0404.2018.3(part1).142335

10. Declèves A. E., Sharma K. Obesity and kidney disease: differential effects of obesity on adipose tissue and kidney inflammation and fibrosis. *Curr Opin Nephrol Hypertens*. 2015 Jan. (Vol. 24, No. 1). P. 28-36. doi: https://doi.org/10.1097/MNH.0000000000000087. PMID: 25470014; PMCID: PMC4847436

11. Obesity, kidney dysfunction and hypertension: mechanistic links / J. E. Hall et al. *Nat. Rev. Nephrol*. 2019. Vol. 15. P. 367-385
DOI: https://doi.org/10.1038/s41581-019-0145-4

12. Pharmacological management of obesity: an endocrine society clinical practice guideline / C. M. Apovian et al. 2015. DOI: https://doi.org/10.1210/jc.2014-3415

13. Tian S., Xu Y. Association of sarcopenic obesity with the risk of all-cause mortality: a meta-analysis of prospective cohort studies. *Geriatr Gerontol Int*. 2016. Vol. 169, No. 2. P. 155-166.
DOI: https://doi.org/10.1186/s12877-019-1195-y

14. 2018 ESC/ESH Guidelines for the management of arterial hypertension / B. Williams et al. *J Hypertens*. 2018. No. 36. P. 1953-2041.
DOI: https://doi.org/10.1097/HJH.0000000000001940

15. 2018/ESH Guidelines for the management of arterial hypertension: The Task Force for the management of arterial hypertension of the European Society of Cardiology (ESC) and the European Society of Hypertension (ESH). *European Heart Journal*. 2018. 01 Sep. (Vol. 39, No. 33). P. 3021-3104.
DOI: https://doi.org/10.1093/eurheartj/ehy339

◆