DOI: 10.20514/2226-6704-2024-14-2-116-123
УДК 616.61-002.2-07-053.9
EDN: MOMXRZ

Е.В. Ефремова*[1], А.М. Шутов[1], Т.С. Кузнецова[2]

[1] — ФГБОУ ВО «Ульяновский государственный университет», Ульяновск, Россия
[2] — ГУЗ Ульяновская областная клиническая больница, Ульяновск, Россия

ВКЛАД ПАТОЛОГИИ ПОЧЕК В РАСЧЕТНУЮ СКОРОСТЬ КЛУБОЧКОВОЙ ФИЛЬТРАЦИИ У ПАЦИЕНТОВ СТАРШЕЙ ВОЗРАСТНОЙ ГРУППЫ

E.V. Efremova*[1], A.M. Shutov[1], T.S. Kuznetsova[2]

[1] — Ulyanovsk State University, Ulyanovsk, Russia
[2] — Ulyanovsk Regional Clinical Hospital, Ulyanovsk, Russia

Chronic kidney disease in older patients: the contribution of kidney pathology to the estimated glomerular filtration

Резюме

Цель — оценить значение вклада патологии почек в расчетную скорость клубочковой фильтрации и его прогностическое значение у пациентов пожилого и старческого возраста. **Материалы и методы.** Обследовано 472 пациента (241 женщина и 231 мужчина, средний возраст 69,6±7,3 лет) со стабильной сердечно-сосудистой патологией пожилого и старческого возраста. ХБП наблюдалась у 302 (63,9 %) пациентов пожилого и старческого возраста. Расчетную скорость клубочковой фильтрации (рСКФ) определяли, используя уравнение CKD-EPI (модификация 2011). Вклад патологии почек (ВПП) в рСКФ рассчитывали по разнице между «реальной» рСКФ (рассчитанной по формуле CKD-EPI, 2011 на основании «реального» креатинина сыворотки) и прогнозируемой для данного возраста и пола рСКФ (патент № RU 2723748 C1). Срок наблюдения составил 12 месяцев. В качестве первичной конечной точки оценивалась общая смертность. **Результаты.** ВПП в рСКФ у пациентов пожилого и старческого возраста составил 26,3 (14,9;35,7) %, увеличиваясь с тяжестью ХБП. ВПП в рСКФ у пациентов пожилого и старческого возраста с ХБП не различался в зависимости от пола и возраста (p >0,05). Модифицированный индекс коморбидности Чарлсон был более высоким у пациентов с ХБП с ВПП в рСКФ более 43,3 % по сравнению с пациентами с ВПП в рСКФ менее 43,3 (p=0,004). ВПП в рСКФ более 43,3 % ассоциировался с риском смерти в течение года у пациентов с ХБП (ОР 4,7; 95 % ДИ 1,99–10,9; p<0,0001). При оценке прогностического значения ВПП в рСКФ независимо от наличия ХБП установлено, что увеличение ВПП в рСКФ более 17,9 % ассоциировано с риском смерти в течение года у пациентов пожилого и старческого возраста со стабильной сердечно-сосудистой патологией (ОР 2,47; 95 % ДИ 1,31–4,67; p=0,004). **Заключение.** ВПП в рСКФ у пациентов пожилого и старческого возраста с ХБП и стабильной сердечно-сосудистой коморбидностью увеличивается с тяжестью ХБП и не зависит от пола и возраста. У пациентов пожилого и старческого возраста со стабильной сердечно-сосудистой патологией ВПП в рСКФ имеет прогностические преимущества при оценке годовой летальности по сравнению с оценкой рСКФ по формуле CKD EPI (2011).

Ключевые слова: *хроническая болезнь почек, вклад патологии почек, пациенты пожилого и старческого возраста*

Конфликт интересов

Авторы заявляют, что данная работа, её тема, предмет и содержание не затрагивают конкурирующих интересов

Источники финансирования

Авторы заявляют об отсутствии финансирования при проведении исследования

Статья получена 22.01.2024 г.
Принята к публикации 14.03.2024 г

Для цитирования: Ефремова Е.В., Шутов А.М., Кузнецова Т.С. **ВКЛАД ПАТОЛОГИИ ПОЧЕК В РАСЧЕТНУЮ СКОРОСТЬ КЛУБОЧКОВОЙ ФИЛЬТРАЦИИ У ПАЦИЕНТОВ СТАРШЕЙ ВОЗРАСТНОЙ ГРУППЫ**. Архивъ внутренней медицины. 2024; 14(2): 116-123. DOI: 10.20514/2226-6704-2024-14-2-116-123. EDN: MOMXRZ

*Контакты: Елена Владимировна Ефремова, e-mail: lena_1953@mail.ru
*Contacts: Elena V. Efremova, e-mail: lena_1953@mail.ru
ORCID ID: https://orcid.org/0000-0002-7579-4824

Abstract

The purpose of the study was to assess the contribution of kidney pathology to the estimated glomerular filtration rate and its prognostic value in elderly and senile patients. **Materials and methods.** 472 elderly and senile age patients (241 women and 231 men, mean age 69.6±7.3 years) with stable cardiovascular diseases were examined. CKD was observed in 302 (63.9 %) elderly and senile patients. Estimated glomerular filtration rate (eGFR) was determined using the CKD-EPI equation (modified 2011). The contribution of kidney pathology (CKP) to eGFR was calculated by the difference between the "real" eGFR (calculated using the CKD-EPI, 2011 formula based on the "real" serum creatinine) and the predicted eGFR for a given age and sex (patent No. RU 2723748 C1). The follow-up period was 12 months. The primary endpoint was overall mortality. **Results.** The CKP in eGFR in elderly and senile patients was 26.3 (14.9;35.7) %, increasing with the severity of CKD. The CKP in eGFR in elderly and senile patients with CKD did not differ depending on gender and age (p>0.05). The modified Charlson comorbidity index was higher in patients with CKD with CKP in eGFR more than 43.3 % compared to patients with The CKP in eGFR less than 43.3 (p = 0.004). The CKP in eGFR more than 43.3 % was associated with a 1-year risk of death in patients with CKD (OR 4.7; 95 % CI 1.99–10.9; p<0.0001). When assessing the prognostic value of CKP in eGFR, regardless of the CKD it was found that an increase CKP in eGFR more than 17.9 % was associated with a 1-year risk of death in elderly and senile patients with stable cardiovascular diseases (OR 2.47; 95 % CI 1.31–4.67; p=0.004). **Conclusion.** The CKP in eGFR in elderly and senile patients with CKD and stable cardiovascular comorbidity increases with the severity of CKD and does not depend on gender and age. In elderly and senile patients with stable cardiovascular diseases, the CKP in eGFR has prognostic advantages when assessing annual mortality compared to eGFR assessment using the CKD EPI formula (2011).

Key words: *chronic kidney disease, contribution of kidney pathology, elderly and senile patients*

Conflict of interests

The authors declare no conflict of interests

Sources of funding

The authors declare no funding for this study

Article received on 22.01.2022
Accepted for publication on 14.03.2024

For citation: Efremova E.V., Shutov A.M., Kuznetsova T.S. The contribution of kidney pathology to the estimated glomerular filtration rate in older age group patients. The Russian Archives of Internal Medicine. 2024; 14(2): 116-123. DOI: 10.20514/2226-6704-2024-14-2-116-123. EDN: MOMXRZ

AH — arterial hypertension, CABG — coronary artery bypass grafting, BP — blood pressure, RPC — renal pathology contribution, CI — confidence interval, IHD — ischemic heart disease, MI — myocardial infarction, CInd — comorbidity index, ACE — acute cerebrovascular event, OR — odds ratio, eGFR — estimated glomerular filtration rate, AF — atrial fibrillation, CKD — chronic kidney disease, CHF — chronic heart failure, PCI — percutaneous coronary intervention.

Introduction

The key causes of a chronic disease are still arterial hypertension and diabetes mellitus [1, 2]. Age is an independent non-modifiable risk factor for chronic kidney disease (CKD) development and progression, with chronic kidney disease being a sign of premature ageing [3, 4]. In elderly and old patients, CKD is not always timely diagnosed and is often seen as age-related changes of the renal function [5]. Some authors propose introducing a term "age-related deterioration in renal function" in order to prevent a hike in the incidence of CKD in elderly patients [6]. At the same time, despite any age-related changes, reduction in glomerular filtration rate is not mandatory in healthy population [7].

The varying significance of the age factor needs to be taken into account: younger patients with eGFR of less than 45 mL/min/1.73 m^2 have a higher risk of end-stage kidney failure; on the contrary, in 85-year-old patients, the risk of death outweighs the risk end-stage kidney failure irrespective of the eGFR value [8]. It is worth mentioning that in elderly patients, CKD is usually diagnosed due to an isolated reduction in estimated glomerular filtration rate and not albuminuria [9, 10]. Estimated glomerular filtration rate will not allow assessing the contribution from pathology to eGFR, since this parameter also includes age-related reduction in renal function.

Study objective: To assess the significance of renal pathology contribution to the estimated glomerular filtration rate and its prognostic value in elderly and old patients.

Materials and Methods

We examined 472 elderly and old patients (241 female and 231 male patients, mean age: 69.6 ± 7.3 years old) with a stable cardiovascular pathology. Elderly patients were aged 60–74 years old, while old patients were aged 75–89 years old, according to the World Health Organisation's criteria (2012) [11].

The study is an open-label, prospective, cohort study using continuous sampling method. Exclusion criteria were: acute cardiovascular pathology (acute myocardial infarction, instable angina, decompensated cardiac failure, acute cerebrovascular event within six months prior to enrolment); end-stage renal disease requiring replacement renal therapy, clinically apparent hepatic failure, acute infectious diseases and/or chronic disease relapses, mental disorders, apparent cognitive disorders which hinder tests, absence of the informed consent to take part in the study. The follow-up period was 12 months. Overall mortality was the primary endpoint.

CKD was diagnosed in accordance with the National Guidelines on the Key Principles of Screening, Diagnosis, Prevention and Management of Chronic Kidney Disease (Russian National Society of Nephrology, 2012) [12]. The analysis took into account the Clinical Guidelines

on the Chronic Kidney Disease (Russian Nephrology Association, 2021) [2].

Estimated glomerular filtration rate (eGFR) was determined using a formula proposed by the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration, 2011 modification). Renal pathology contribution (RPC) to estimated glomerular filtration rate (eGFR) was calculated on the basis of the difference between the actual eGFR (calculated using CKD-EPI, 2011 formula on the basis of the real blood creatinine value) and eGFR value predicted for a specific age and sex, assuming that serum creatinine is 80 μmol/L for women and 100 μmol/L for men (Patent No. RU 2723748 C1), formula (1).

$$A\ (\%) = (B\text{-}C)*100\ \% / B, \quad (1)$$

where A is renal pathology contribution to estimated glomerular filtration rate;

B is a predicted (optimal) estimated glomerular filtration rate;

C is the real estimated glomerular filtration rate.

Cardiovascular pathologies were diagnosed in accordance with the current Russian guidelines.

Clinical characteristics of subjects are presented in Table 1.

Chronic kidney disease was diagnosed in 302 (63.9 %) of elderly and old patients. More common was CKD with eGFR of less than 60 mL/min/1.73 m2 — 277 patients (91.7 %) out of 302. CKD was diagnosed on the basis of an isolated reduction in eGFR below 60 mL/min/1.73 m2 — in 218 CKD patients (72.2 %). Structural renal changes were observed in 67 CKD patients (22.2 %), albuminuria/proteinuria — in 62 CKD patients (20.5 %) (n = 302). Thus, there were no cases of stage 1 CKD; stage 2 CKD was diagnosed only in 25 patients (8.3 %), stage 3a was observed in 185 patients (61.3 %), 3b — in 83 patients (27.5 %), stage 4 — in 9 patients (2.9 %) of elderly and old age (n = 302).

Comorbidity was assessed in accordance with the Clinical Guidelines on Comorbid Pathologies in Clinical Practice [13], modified Charlson comorbidity

Table 1. *Clinical characteristics of elderly and senile patients with stable cardiovascular diseases*

Parameters	n=472
Women, n (%)	241(51)
Men, n (%)	231(49)
Age (M±SD, years)	69,6±7,3
Location:	
urban residents, n (%)	415(87,9)
rural residents, n (%)	57(12,1)
Smoking, n (%)	55(11,7)
Heredity for cardiovascular pathology, n (%)	205(43,4)
AH, n (%)	452 (95,8)
CHF, n (%)	335 (70,1)
CAD, n (%)	349 (74)
including history of myocardial infarction, n (%)	132 (27,9)
History of PCI/CABG, n (%)	54 (11,4)
AF, (n%)	156 (33)
including permanent AF, n (%)	81 (17,2)
Diabetes mellitus type 2, n (%)	129 (27,3)
Peripheral artery disease, n (%)	70 (14,8)
History of stroke, n (%)	60 (12,7)
Non-coronary heart diseases (cardiomyopathies, heart defects), n (%)	48 (10,2)
Pathology of the musculoskeletal system, n (%)	275 (58,2)
Obesity, n (%)	200 (42,4)
Dementia, n (%)	97 (20,5)
Anemia, n (%)	92 (19,1)
Pathology of the thyroid gland, n (%)	73 (15,4)
Primary kidney diseases (chronic glomerulonephritis, chronic pyelonephritis, urolithiasis), n (%)	67 (14,2)
Chronic nonspecific lung diseases (chronic obstructive pulmonary disease, bronchial asthma), n (%)	47 (9,9)
Peptic ulcer, n (%)	27 (5,7)
Connective tissue diseases, n (%)	19 (4,0)
Malignant tumors without metastases (complete remission >5 years are excluded), n (%)	18 (3,8)
History of viral hepatitis, n (%)	11 (2,3)

Notes. AH — arterial hypertension, CABG — coronary artery bypass grafting, CAD — coronary artery disease, CI — comorbidity index, ACVA — acute cerebrovascular accident, AF — atrial fibrillation, CKD — chronic kidney disease, CHF — chronic heart failure, PCI — percutaneous coronary intervention

index (CInd) was used (Patent No. RU 2706975 C1) [10]. Comorbidity was high is CInd was more than 6 points.

Statistical data analysis was performed using StatSoft-Statistica v.10.0.1011.6 (StatSoft, Inc, USA) and MedCalc 11.6 (MedCalc Software Ltd, Belgium). Data distribution was assessed using Shapiro–Wilk's W test. Depending on analysis results, data were presented as M±SD, where M is the arithmetic mean, SD is standard deviation (in normal distribution), or Me (IQR), where Me is median, IQR is interquartile range: 25th percentile–75th percentile (in a distribution other than normal). Groups were compared using Student t-test and Mann–Whitney U test) (in a distribution other than normal). Test method accuracy was assessed using ROC analysis; event probability was predicted using logistic regression analysis. Survival rate analysis was performed using Kaplan–Meier method. Qualitative parameters were compared using Pearson's chi-square test. Differences were statistically significant at $p < 0.05$.

Results

Pathology contribution to eGFR in elderly and old patients was 26.3 % (14.9 %;35.7 %) %, increasing along CKD severity (Fig. 1).

Given the concept of the cardiorenal syndrome (where failure of one organ causes impaired function of the other organ), stage 2 CKD patients were not included in the analysis, and negative RPC values are probably associated with hyperfiltration and preserved filtration function at this CKD stage.

Renal pathology contribution to eGFR in elderly and old patients was independent of the age: 23.1 % (17.3 %;36.1 %) and 25.6 % (12.7 %;36.7 %) for man and women, respectively, $p = 0.19$. There were no differences in RPC to eGFR in elderly and old patients: 26.3 % (16.2 %;33.7 %) and 26.4 % (11.0 %;36.7 %), respectively, $p = 0.81$) (relationship between RPC to eGFR and patient age: $r = -0.09$, $p = 0.13$) (Fig. 2).

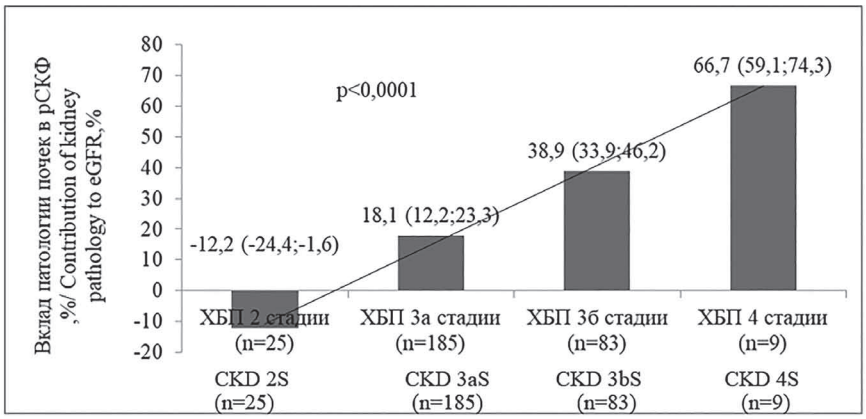

Figure 1. *Contribution of kidney pathology to eGFR in elderly and senile patients depending on the stage of CKD*
Notes eGFR — estimated glomerular filtration rate, CKD — chronic kidney disease

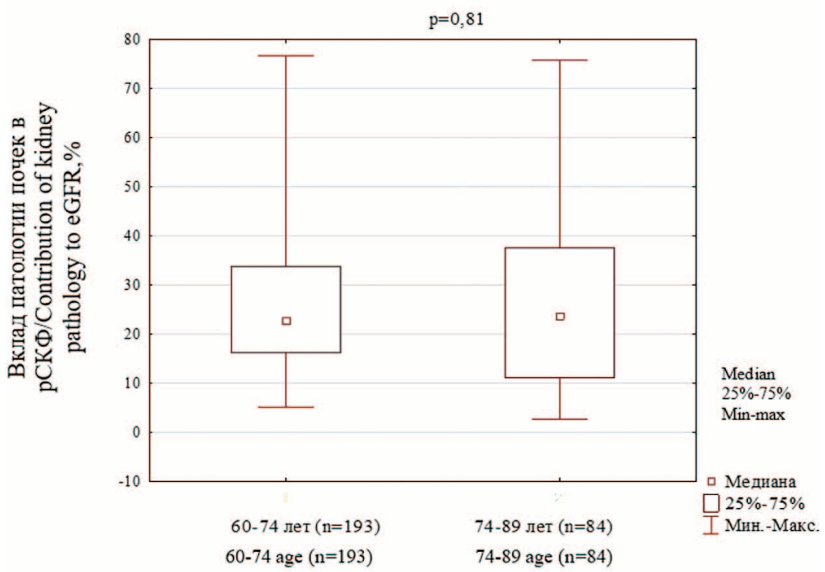

Figure 2. *Contribution of kidney pathology to eGFR in elderly and senile patients depending on age group*
Notes eGFR — estimated glomerular filtration rate

Out of 472 elderly and old patients with stable cardiovascular pathology, prognosis was assessed in 405 patients (85.8 %). During the follow-up period, 47 elderly and old patients (11.6 %) with a stable cardiovascular pathology (38 patients with CKD and 9 patients without CKD) died. Given the lack of the data on the cause of death in a number of patients, cardiovascular mortality was no analysed.

The logistic regression analysis established that the presence of CKD with eGFR of less than 60 mL/min/1.73 m² in elderly and old patients with cardiovascular pathologies is associated with a considerable risk of one-year mortality (OR 2.37; 95 % CI 1.11–5.09; p = 0.017).

Assessment of the prognostic value of RPC to eGFR in elderly and old patients with a stable cardiovascular pathology with or without CKD demonstrated that an increase in RPC to eGFR of over 17.9 % is associated with one-year mortality in elderly and old patients with stable a cardiovascular pathology (OR 2.47; 95 % CI 1.31–4.67; p = 0.004) (Fig. 3).

Renal pathology contribution to estimated GFR of over 43.3 % was associated with a risk of one-year mortality in elderly and old patients with CKD with eGFR of less than 60 mL/min/1.73 m² (OR 4.7; 95 % CI 1.99–10.9; p < 0.0001). Patient survival analysis is presented in Figure 4.

An increase in RPC to eGFR of over 43.3 % was associated with anaemia (OR 2.81; 95 % CI 1.28–6.17; p = 0.009), a history of acute cerebrovascular event

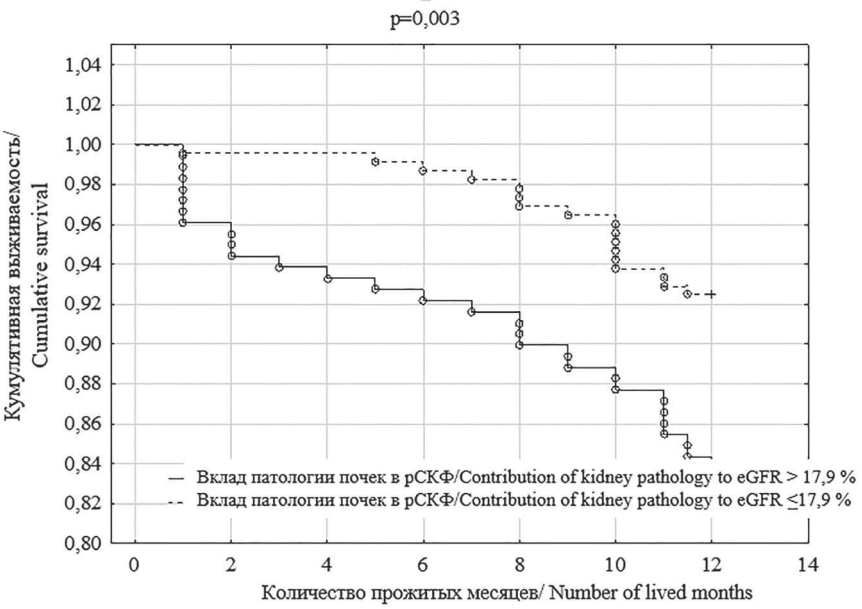

Figure 3. *Cumulative survival of elderly and senile patients with stable cardiovascular pathology depending on the contribution of kidney pathology to eGFR*

Notes. eGFR — estimated glomerular filtration rate, CKD — chronic kidney disease

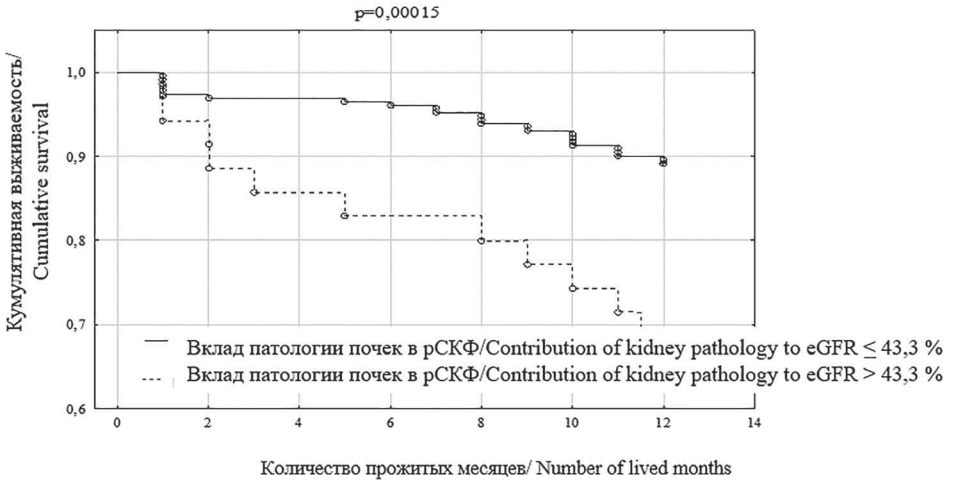

Figure 4. *Cumulative survival of elderly and senile patients with CKD with eGFR less than 60 ml/min/1.73 m² depending on the contribution of kidney pathology to eGFR*

Notes. eGFR — estimated glomerular filtration rate, CKD — chronic kidney disease

(OR 2.82; 95 % CI 1.19–6.66; p = 0.02), atrial fibrillation (OR 2.37; 95 % CI 1.07–5.28; p = 0.03) (Table 2).

Modified Charlson comorbidity index was higher in patients with CKD with RPC to eGFR of over 43.3 % vs. patients with RPC to eGFR of less than 43.3 %: 8 (6;9) and 7 (6;8), respectively, p = 0.004.

Clinical and laboratory values in elderly and old patients with a stable cardiovascular pathology and CKD, depending on RPC to eGFR, are presented in Table 3.

Elderly and old patients with CKD with RPC to eGFR of over 43.3 % had higher body mass index as compared with patients with RPC to eGFR of less than 43.3 % (p = 0.02). Also, it is worth mentioning that elderly and old patients with CKD and RPC of over 43.3 % had higher WBC count (p = 0.005), neutrophils count (p = 0.003) and neutrophil/lymphocyte ratio (p = 0.008). Besides, in patients with CKD and RPC to eGFR of over 43.3 %, serum potassium was higher than in patients with CKD and lower RPC to eGFR: 4.9 (4.4;5.7) and 4.5 (4.1;4.9) mmol/L, respectively, p = 0.004.

Table 2. *Relationship between the contribution of kidney pathology to eGFR more than 43.3 % and comorbidity in patients with CKD with eGFR less than 60 ml/min/1.73 m²*

Comorbidity parameters	OR	95 % CI	p
Diabetes	1,29	0,59–2,79	0,51
Metabolic syndrome	1,1	0,51–2,42	0,79
Obesity	1,81	0,89–3,68	0,09
Coronary artery disease	1,35	0,6–3,04	0,46
History of myocardial infarction	1,02	0,49–2,15	0,95
CHF	0,74	0,15–3,55	0,70
History of stroke	2,82	1,19–6,66	0,02
Anemia	2,81	1,28–6,17	0,009
Atrial fibrillation	2,37	1,07–5,28	0,03

Notes. CI — confidence interval, ACVA — acute cerebrovascular accident, OR — odds ratio, eGFR — estimated glomerular filtration rate, CKD — chronic kidney disease, CHF — chronic heart failure

Table 3. *Clinical and laboratory parameters of elderly and senile patients with CKD with eGFR less than 60 ml/min/1.73 m2 depending on the contribution of kidney pathology in eGFR*

Parameters Me(IQR)	Patients with a contribution of kidney pathology to eGFR of more than 43.3 % (n=36)	Patients with a contribution of kidney pathology to eGFR of less than 43.3 % (n=241)	p
Body mass index, kg/m²	30,4 (27;37,9)	29,0 (25,9;32,7)	0,02
Body fat mass index, kg/m²	11,1 (9,4;17,4)	10,2 (7,9;12,9)	0,02
6-minute walk test, m	305,5 (295;350)	302,5 (290;380)	0,53
SBP, mmHg	130 (130;142,5)	135(139;144)	0,66
DBP, mm Hg.	80 (80;90)	80 (80;90)	0,95
Heart rate, beats per minute	76 (71;84)	72,5 (66;83,5)	0,19
Hemoglobin, g/l	122,5(112;148)	135(121;148)	0,08
Red blood cells, 10^{12}/л	4,5 (3,9;4,9)	4,5 (4;4,8)	0,82
Leukocytes*10^9/л	8,4 (6,4;11,8)	6,8 (5,5;8,2)	0,005
Neutrophils, *109/l	5,7 (4,4;8,4)	4,1 (3,3;5,3)	0,003
Lymphocytes, *10^9/l	1,7 (1,4;2,2)	1,8 (1,4;2,2)	0,72
Monocytes, *10^9/л	0,4 (0,3;0,6)	0,4 (0,2;0,6)	0,77
Eosinophils, *10^9/л	0,09 (0;0,22)	0,07 (0;0,15)	0,59
N/L ratio	3,2 (2,3;5,3)	2,3 (1,7;3,4)	0,008
Eo/Leu ratio	0,03 (0;0,22)	0,02 (0,01;0,07)	0,24
M/L ratio	0,29 (0,17;0,4)	0,24 (0,15;0,35)	0,46
Platelets, * 10^9/л	224 (178;269)	219 (189;268)	0,68
ESR, mm/h	18,5 (11;36,5)	12 (6;22)	0,01
Blood glucose, mmol/l	6,3 (5,4;6,9)	5,9 (5,2;7)	0,56
Total protein, g/l /Total cholesterol, mmol/l	68,4(62,8;71;6)	69,8(64,7;74;4)	0,08
Total cholesterol, mmol/l /	4,7(3,6;5,7)	4,9(3,9;5,8)	0,05
Triglycerides, mmol/l	1,34(0,95;1,49)	1,19(0,87;1,78)	0,82
Sodium, mmol/l	140,5 (137;143,5)	142 (139;144)	0,15
Potassium, mmol/l	4,9 (4,4;5,7)	4,5 (4,1;4,9)	0,004
Fibrinogen, g/l	3,5 (3;4,8)	3,3 (2,7;4,0)	0,16

Notes. DBP — diastolic blood pressure, BMI — body fat mass, SBP — systolic blood pressure, ESR — erythrocyte sedimentation rate, eGFR — estimated glomerular filtration rate, CKD — chronic kidney disease, HR — heart rate. N/L ratio — ratio of neutrophils to lymphocytes, Eo/Leu ratio — ratio of eosinophils to leukocytes, M/L ratio — ratio of monocytes to lymphocytes

Discussion

Renal function impairment with ageing is a serious concern: in individuals over 40 years of age, GFR reduces by 1 mL/min/1.73 m^2 [4, 14]. Age-related reduction in GFR is caused by glomerular sclerosis, tubular atrophy, reduced cortex activity and smaller kidney size [15-17]. Age-related changes in tubular function result in impaired sodium reabsorption, with it being a risk factor for rapid dehydration in elderly people; reduced potassium excretion causing, together with medications, hyperkalaemia; impaired concentration capacity of kidneys, which leads to nocturnal enuresis [18].

In elderly patients, reduced renal function is associated with almost two-fold increase in the incidence of arterial hypertension, ischemic heart disease and cardiac failure [19]. In addition to eGFR assessment, it is essential to take into account the gerontological status of elderly patients (frailty, cognitive disorders, self-care ability) and their comorbidities [20, 21].

The use of calculation formulas for GFR assessment in elderly people with CKD has a number of limitations. The MDRD (Modification of Diet in Renal Disease) and CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) formulas are highly accurate, but they underestimate CKD severity in this cohort [22]. The use of the Cockcroft-Gault equation in elderly people is also inaccurate, mostly because the equation uses body weight in calculations: elderly people have less lean body mass due to comorbidities, frailty and malnutrition. In validation of calculation formulas, the number of elderly people over 70 years of age was insufficient. For instance, for the MDRD formula, the mean age in the population was 50.6 ± 12.7 years old, for the Cockcroft-Gault equation, the percentage of patients over 70 years of age was just 23 % [23, 24]. Also, it is worth mentioning that among elderly and old people with CKD there are a lot of patients with diabetes mellitus, who experience hyperfiltration even at early stages of diabetic nephropathy [25].

Given the complexity and ambiguousness of the approach used for elderly and old patients with CKD, the European Renal Association–European Dialysis Transplantation Association (ERA-EDTA) and the European Union Geriatric Medicine Society (EUGMS) developed Clinical Guidelines for the management of elderly patients with stage 3b+ chronic kidney disease [26]. The CKD-EPIcr-cys equation is proposed to be used as the most optimal alternative to direct measurement of the renal function in elderly people (2C is a low-quality recommendation with a low level of evidence) [26].

Therefore, it is recommended to use CKD-EPIcr-cys both for the screening of elderly patients and development of a treatment approach. However, in this case, it is still unclear how a renal pathology contributes to estimated glomerular filtration rate. The proposed method for the determination of RPC is better in forecasting the risk of mortality in elderly people with CKD and a cardiovascular comorbidity.

Conclusion

Renal pathology contribution to estimated GFR in elderly and old patients with CKD and a cardiovascular comorbidity grows along with CKD severity and is independent of sex and age. In elderly and old patients with a stable cardiovascular pathology, renal pathology contribution to estimated GFR of over 17.9 % has prognostic significance in the assessment of one-year mortality vs. eGFR calculation using the CKD EPI formula (as modified in 2011) (OR 2.47; 95 % CI 1.31–4.67; p = 0.004).

Вклад авторов:

Все авторы внесли существенный вклад в подготовку работы, прочли и одобрили финальную версию статьи перед публикацией

Ефремова Е.В. (ORCID ID: https://orcid.org/0000-0002-7579-4824): разработка концепции и дизайна, обзор публикаций по теме статьи, написание текста статьи, одобрение окончательной версии статьи перед подачей для публикации

Шутов А.М. (ORCID ID: https://orcid.org/0000-0002-1213-8600): разработка концепции и дизайна, обзор публикаций по теме статьи, написание текста статьи, одобрение окончательной версии статьи перед подачей для публикации

Кузнецова Т.С. (ORCID ID: https://orcid.org/0009-0002-5340-7341): обзор публикаций по теме статьи, научная консультация, одобрение окончательной версии статьи перед подачей для публикации

Author Contribution:

All the authors contributed significantly to the study and the article, read and approved the final version of the article before publication

Efremova E.V. (ORCID ID: https://orcid.org/0000-0002-7579-4824): development of the concept and design, review of publications on the topic of the article, writing the text of the article, approval of the final version of the article before submission for publication

Shutov A.M. (ORCID ID: https://orcid.org/0000-0002-1213-8600): development of the concept and design, review of publications on the topic of the article, writing the text of the article, approval of the final version of the article before submission for publication

Kuznetsova T.S. (ORCID ID: https://orcid.org/0009-0002-5340-7341): review of publications on the topic of the article, scientific consultation, approval of the final version of the article before submission for publication

Список литературы / References:

1. Levin A., Stevens P.E., Bilous R.W., et al. Kidney Disease: Improving Global Outcomes (KDIGO) Chronic Kidney Disease Work Group: KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl 3(1): 1–150, 2013.
2. Ассоциация нефрологов. Клинические рекомендации «Хроническая болезнь почек». 2021; 233 с.
   Association of Nephrologists. Clinical guidelines "Chronic kidney disease". 2021; 233 p. [In Russian]
3. Falodia J., Singla M.K. CKD epidemiology and risk factors. Clin Queries Nephrol. 2012; 1 (4): 249–252. doi: 10.1016/j.cqn.2012.09.004
4. Hommos MS, Glassock RJ, Rule AD. Structural and Functional Changes in Human Kidneys with Healthy Aging. J Am Soc Nephrol. 2017; 28(10): 2838-2844. doi: 10.1681/ASN.2017040421.

5. De Boer I.N. Chronic kidney disease–a challenge for all ages. JAMA. 2012. 308 (22): 2401–2. doi: 10.1001/jama.2012.30761
6. Winearls C.G., Glassock R.J. Classification of chronic kidney disease in the elderly: pitfalls and errors. Nephron Clin Pract.2011;119 (Suppl 1): 2–4. doi: 10.1159/000328013
7. Levey A.S., Becker C., Inker L.A. Glomerular filtration rate and albuminuria for detection and staging of acute and chronic kidney disease in adults: a systematic review. JAMA.2015; 313(8): 837–846. doi: 10.1001/jama.2015.0602
8. O'Hare A.M., Choi A.I., Bertenthal D., et al. Age affects outcomes in chronic kidney disease. J Am Soc Nephrol. 2007; 18(10): 2758–65. doi: 10.1681/ASN.2007040422
9. Томилина Н.А., Бикбов Б.Т. Распространенность и стрСКФтура хронической болезни почек в г. Москве по данным Московского городского регистра. Нефрология и диализ. 2011; 13(3): 361-363. Tomilina N.A., Bikbov B.T. Prevalence and structure of chronic kidney disease in Moscow according to the Moscow City Register. Nephrology and dialysis. 2011; 13(3): 361-363 [In Russian]
10. Ефремова Е.В., Шутов А.М., Ефремов И.М. и др. Использование модифицированного индекса коморбидности Чарлсон для прогноза риска смерти у пациентов с хронической болезнью почек пожилого и старческого возраста. Нефрология и диализ. 2022; 24(2): 349-356. doi: 10.28996/2618-9801-2022-2-349-356 Efremova E.V., Shutov A.M., Efremov I.M., et al. Using the modified Charlson comorbidity index to predict the risk of death in elderly and senile patients with chronic kidney disease. Nephrology and Dialysis. 2022; 24(2):3 49-356. doi: 10.28996/2618-9801-2022-2-349-356. [In Russian]
11. Ткачева О.Н., Котовская Ю.В., Рунихина Н.К. и др. Клинические рекомендации «Старческая астения». Российский журнал гериатрической медицины. 2020; 1: 11-46. doi: 10.37586/2686-8636-1-2020-11-46. Tkacheva O.N., Kotovskaya Yu.V., Runikhina N.K. et al. Clinical guidelines «Senile asthenia». Russian Journal of Geriatric Medicine. 2020; 1: 11-46. doi: 10.37586 / 2686-8636-1-2020- 11-46 [In Russian]
12. Смирнов А.В., Шилов Е.М., Добронравов В.А., и др. Национальные рекомендации. Хроническая болезнь почек: основные принципы скрининга, диагностики, профилактики и подходы к лечению. Нефрология. 2012; 16(1): 89-115. doi: 10.24884/1561-6274-2012-16-1-89-115 Smirnov A.V., Shilov E.M., Dobronravov V.A. et al. National recommendations. Chronic kidney disease: basic principles of screening, diagnosis, prevention, and treatment approaches. Nephrology. 2012; 16 (1): 89-115. doi: 10.24884/1561-6274-2012-16-1-89-115 [In Russian]
13. Оганов Р.Г., Симаненков В.И., Бакулин И.Г., и др. Коморбидная патология в клинической практике. Алгоритмы диагностики и лечения. Кардиоваскулярная терапия и профилактика. 2019; 18(1): 5-66. doi: 10.15829/1728-8800-2019-1- 5-66. Oganov R.G., Simanenkov V.I., Bakulin I.G. et al. Comorbid pathology in clinical practice. Diagnostic and treatment algorithms. Cardiovascular therapy and prevention. 2019; 18 (1): 5-66. doi: 10.15829 / 1728-8800-2019-1-5-66. [In Russian]
14. Epstein, M. Aging and the kidney J Am Soc Nephrol. 1996; 7(8):1106–22. doi: 10.1681/ASN.V781106
15. Silva F.G. The aging kidney: A review–part I. Int Urol Nephrol. 2005.37(1):185–205. doi: 10.1007/s11255-004-0873-6.
16. Silva F.G. The aging kidney: A review–part I. Int Urol Nephrol. 2005.37(2)419–32. doi: 10.1007/s11255-004-0873-6.
17. Rule A.D., Amer H., Cornell L.D., et al. The association between age and nephrosclerosis on renal biopsy among healthy adults. Ann Intern Med.2010; 152(9):561-7. doi: 10.7326/0003-4819-152-9-201005040-00006.
18. Zhou X.J., Rakheja D., Yu X., et al. The aging kidney. Kidney Int.2008;74(6):710-20. doi: 10.1038/ki.2008.319
19. Manjunath G., Tighionart H., Ibrahim H., et al. Level of kidney function as risk factors for atherosclerotic cardi-ovascular outcomes in the community. J Am Coll Cardiol. 2003; 41(1):47-55. doi: 10.1016/s0735-1097(02)02663-3.
20. Nixon A.C., Bampouras T.M., Pendleton N. et al. Frailty and chronic kidney disease: current evidence and continuing uncertainties. Clin Kidney J. 2018;11(2):236-245. doi: 10.1093/ckj/sfx134
21. Koncicki H.M., Swidler M.A. Decision making in elderly patients with advanced kidney disease. Clin Geriatr Med. 2013; 29(3):641-55. doi: 10.1016/j.cger.2013.05.004.
22. Burkhardt H., Hahn T., Gretz N., Gladisch R. Bedside estimation of the glomerular filtration rate in hospital-ized elderly patients. Nephron Clin Pract. 2005;101(1):1–8. doi: 10.1159/000085705.
23. Cockcroft D.W., Gault M.H. Prediction of creatinine clearance from serum creatinine. Nephron. 1976;16(1):31–41. doi: 10.1159/000180580
24. Levey, A.S. Bosch J.P., Lewis J.B., et al. A more accurate method to estimate glomerular filtration rate from serum creatinine: a new prediction equation. Modification of Diet in Re-nal Disease Study Group Ann Intern Med. 1999.16;130(6):461-70.
25. Mussap M., Vestra M.D., Fioretto P., et al. Cystatin C is a more sensitive marker than creatinine for the estimation of GFR in type 2 diabetic patients. Kidney Int. 2002;61(4):1453–61.
26. Farrington K., Covic A., Nistor I., et al. Clinical Practice Guideline on management of older patients with chronic kidney disease stage 3b or higher (eGFR<45 mL/min/1.73 m2): a summary document from the European Renal Best Practice Group. Nephrol Dial Transplant. 2017;32(1):9-16. doi: 10.1093/ndt/gfw411.