

Comorbidity Background and Rehabilitation Potential Among the Cerebral Stroke Patients

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ABSTRACT

Stroke is one of the most significant social problems due to the high incapacitation rates among the patients. The rehabilitation of the patients in the older age group with stroke consequences is complicated by the fact that they almost always have a comorbidity background, influencing the efficiency of restoring the lost functions and the possibilities of using any technologies of medical rehabilitation. Comorbidity makes its contribution to the development of repeated stroke and plays a significant role when drafting the rehabilitation program. The review analyzes the data from scientific literature on the effects of concomitant diseases on the rehabilitation potential of patients after a past acute cerebrovascular accident. An analysis was carried out for the literature data using three data bases (PubMed, MEDLINE and eLIBRARY) for the period from 2000 until 2025 with 435 scientific articles analyzed, and for the detailed analysis, 35 publications were selected that meet the inclusion criteria. Based on the analysis conducted, various options were presented for evaluating the rehabilitation potential and for interpreting the evaluation results with taking into consideration the effect of various diseases, most frequently seen in patients with acute cerebrovascular accident. A discussion is presented on the necessity of compiling a single unified method of determining the rehabilitation potential. The analysis of literature data has shown that evaluating the comorbidity is one of the important components of the rehabilitation potential in the patient after the stroke. Determining the most significant factors shaping the rehabilitation potential in such patients is a top priority task determining the choice of rehabilitation therapy tactics and its efficiency.

Keywords: rehabilitation potential; concomitant diseases; comorbidity; medical rehabilitation; stroke; incapacitation.

For citation:

Polyaev BB, Ivanova GE, Bulatova MA, Fuchizhi OV. Comorbidity Background and Rehabilitation Potential Among the Cerebral Stroke Patients. *Journal of Clinical Practice*. 2025;16(3):88–97. doi: 10.17816/clinpract688749 EDN: PQUFQQ

Submitted 07.08.2025

Accepted 15.09.2025

Published online 28.09.2025

INTRODUCTION

Stroke is the leading disease in terms of the degree of incapacitation among the patients. According to statistical data, among the surviving patients, to the end of acute period of the disease, more than 80% have persisting motor and cognitive disorders of various degree of intensity [1]. For achieving the maximum treatment effect, the medication therapy must be obligatorily combined with medical rehabilitation and with preventive measures [2].

Medical rehabilitation is an integral part of treating the patients after an acute cerebrovascular accident (CVA) and it must be used taking into consideration the mechanisms of spontaneous convalescence in the acute, the subacute and the recovery periods of stroke, as well as during the period of residual effects [3]. With this, one of the important problems remaining is the risk of repeated stroke, which is approximately 30%

and which is most frequently developing in the first two years after the CVA [4], which has great importance for organizing the rehabilitation and preventive activities. The World Health Organization has verified more than 300 various risk factors of developing the CVA, however, the top priority ones are only the factors which show a high rate of incidence in various populations, significantly affecting development of stroke, and influencing which by means of timely preventive activities decreases the CVA incidence. The combination of several such factors increases the risk of developing the CVA [5]. The age plays a significant role in determining the program of rehabilitation activities, for the elderly patients in the majority of cases have a comorbidity background influencing the rate of reparative processes and the possibility of using various technologies of medical rehabilitation [6]. Thus, investigating the role of concomitant diseases in stroke patients at all the stages

Коморбидный фон и реабилитационный потенциал пациентов после перенесённого церебрального инсульта

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АННОТАЦИЯ

Инсульт является одной из наиболее значимых социальных проблем вследствие высокого уровня инвалидизации пациентов. Реабилитация пациентов старшей возрастной группы с последствиями инсульта затрудняется тем, что у них почти всегда присутствует коморбидный фон, оказывающий влияние на эффективность восстановления утраченных функций и возможность применения тех или иных технологий медицинской реабилитации. Коморбидность вносит свой вклад в развитие повторного инсульта и играет значимую роль при составлении программы реабилитации. В обзоре проанализированы данные научной литературы о влиянии сопутствующих заболеваний на реабилитационный потенциал пациентов после перенесённого острого нарушения мозгового кровообращения. Проведён анализ литературы по трём базам данных (PubMed, MEDLINE и eLIBRARY) за период с 2000 по 2025 год, проанализированы 435 научных статей, для детального анализа отобрано 35 публикаций, соответствующих критериям включения. На основании проведённого анализа представлены различные варианты оценки реабилитационного потенциала и интерпретации результатов оценки с учётом влияния различных заболеваний, наиболее часто встречающихся у пациентов с острым нарушением мозгового кровообращения. Анализ литературы показал, что оценка коморбидности является одной из важных составляющих реабилитационного потенциала пациента после перенесённого инсульта. Определение наиболее значимых факторов, формирующих реабилитационный потенциал у таких пациентов, является первостепенной задачей, определяющей выбор тактики реабилитационного лечения и его эффективность.

Ключевые слова: реабилитационный потенциал; сопутствующие заболевания; коморбидность; медицинская реабилитация; инсульт; инвалидизация.

Для цитирования:

Поляев Б.Б., Иванова Г.Е., Булатова М.А., Фучижи О.В. Коморбидный фон и реабилитационный потенциал пациентов после перенесённого церебрального инсульта. Клиническая практика. 2025;16(3):88–97. doi: 10.17816/clinpract688749 EDN: PQUFQQ

Поступила 07.08.2025

Принята 15.09.2025

Опубликована online 28.09.2025

of treating the disease must become the obligatory component of modern neuro-rehabilitation.

The problem of the unified evaluation of the rehabilitation potential is primarily resulting from the needs of the physicians in having the instrument allowing for timely getting an insight on the potential of restoring various abnormalities of the vital processes with a certain comorbidity background. Besides the medical aspect, this problem has the regulatory and the economical ones.

Regulatory requirements. A Decree issued by the Ministry of Health with a number 788n¹ regulates the

obligatory determination of the rehabilitation potential in the patients at all the stages of medical rehabilitation, beginning from Day 1 of disease development and of admittance to the in-patient department. The clinical recommendations on medical rehabilitation for various diseases and conditions of the nervous system also regulate the determination of the rehabilitation potential during the process of providing the aid on medical rehabilitation from the first stage of medical rehabilitation of the patients in the peracute and the acute periods of ischemic stroke, beginning from the Department of Anesthesiology and Resuscitation.

Economical aspect. The possibility of timely and objectively defining the rehabilitation potential determines not only the further adequate routing of the patient, but also the extent of costs for using

¹ Decree issued by the Ministry of Healthcare of the Russian Federation on July 31, 2020, No. 788n "On the Approval of the Procedure for the Organization of Medical Rehabilitation of Adults" (registered on 25.09.2020, No. 60039). Access mode: <http://publication.pravo.gov.ru/Document/View/0001202009250036>

the medical services and the medical rehabilitation technologies, applicable for the treatment of a specific patient. In the evaluation of the economical component of the rehabilitation in patients with a past cerebrovascular stroke, separate attention should be paid to the personnel aspect — the efficiency of using the staff potential of the medical organization involved into the rehabilitation. For the reason that the staff resources of the rehabilitation service is always the limiting factor, the involvement of specialists from the multidisciplinary rehabilitation team (medical logopaedist, neuropsychologist, medical psychologist, ergo-rehabilitation specialist, physical rehabilitation specialist etc.) in everyday practice should be maximally rational and should be conducted primarily for the patients with high and medium rehabilitation potential.

Search methodology

An analysis was carried out using the full-text publications in Russian and English languages from the PubMed, MEDLINE and eLIBRARY data bases for the period from 2000 until 2025 using the following key words: “rehabilitation potential in stroke”, “prognosis after a stroke”, “stroke outcome”; as the second search criterion, the queries used were “concomitant disorders”, “comorbidity” and “concomitant diseases”. During the initial search, 435 sources were extracted, of which 35 research works were selected as meeting the inclusion criteria (comorbidity was analyzed at least by one specific rehabilitation result, including the functional status).

THE MAIN COMORBID FACTORS DEFINING THE REHABILITATION POTENTIAL

Due to the fact that rehabilitation potential is an integrative parameter, requiring the multimodal approach to evaluating various factors of the patient's activity, the special role belongs to the evaluation of the presence and the severity of the concomitant diseases present, which may directly affect the potential of restoring the impaired or decreased functions, as well as the adaptation in cases of lost functions.

According to the literature data, patients with cerebrovascular diseases are most commonly prone to developing the circulatory diseases, which, in turn, not only increases the risk of cerebral accident, but also prognostically negatively affects the outcome and the level of incapacitation [7]. Hypertensive disease and heart rhythm disorder, namely the atrial fibrillation, have a certain role not only in the development of stroke, but they also affect the potential of restoring the lost

functions. Atrial fibrillation is the reason of developing vast infarctions and, as a result, it leads to a decrease in the rehabilitation potential and to more severe functional outcomes [8]. The presence of atrial fibrillation in the ischemic stroke patients is not only the predictor of developing more extensive lesions in the brain, but also the factor increasing the mortality rates [9–12]. Arterial hypertension, with its specific changes in the vascular wall, with the specific features of systemic or cerebral circulation and metabolic disorders, is also one of the main reasons of developing the CVA [13]. Patients suffering from hypertensive disease, according to the definition from the World Health Organization, already are at very high risk of cardio-vascular complications, which requires special attention to the adequate and timely prescribing of medication therapy [14]. With this, a number of research works reports that the percentages of patients suffering from arterial hypertension and having a past episode of the initial and repeated CVA, are approximately equal [15].

The elderly age and the presence of cardiac comorbidity are the factors of significant influence on the rehabilitation potential and the functional outcome of rehabilitation after the cerebral stroke [8, 16]. The results from a number of publications show that the presence of chronic cardiac failure itself is a factor restricting the rehabilitation potential and also is an independent risk factor for mortality during various periods of the disease [17, 18]. This effect is associated not only with the limited extent and the technologies applicable during the process of medical rehabilitation, but it is also a limitation of the functional reserves in the organism, which makes it impossible to use a number of technologies and methods of medical rehabilitation in the given category of patients. The presence of cardio-vascular diseases itself is a factor limiting the arrangement of medical rehabilitation, while in the neglected cases — a risk factor for the medical rehabilitation itself [19].

METHODS OF EVALUATING THE REHABILITATION POTENTIAL

Initially, for the purpose of defining the rehabilitation potential, a CIRS system (Cumulative Illness Rating Scale) was proposed [20]. Later on, taking into consideration the specific features of the cerebral stroke patients, the preference was given to the modified version of this score — the CIRS-G (Cumulative Illness Rating Scale-Geriatrics), evaluating the specific features of the patients from the older age group, the one that is most prone to developing the CVA [21]. This scale is quite

comfortable to use and it has a high number of electronic assistants, beginning from online-applications and moving on to online-calculators with the detailed hints for the specialists on its correct filling. The backbone of this score is the evaluation of the presence/severity of impairments in each of the system of organs, the need for therapy to correct the available diseases. The result of questionnaire survey is the interpretation of the severity of the concomitant diseases present [21] (table 1). Along with the CIRS-G score, the proposed options included the use of the Charlson Comorbidity Index (CCI) for scoring the presence or the absence of the certain diseases, applicable for predicting the mortality [22] (table 2). The comparison of the Charlson index and the CIRS-G comorbidity score has shown higher validity of the latter in the evaluation of the parameters in all the categories of patients, with this, the evaluation of the rehabilitation potential was carried

out using the classification proposed by A.R. Sagatov, in which the rehabilitation potential is graded as high, medium, low and absent [23].

Most commonly, the evaluation of the rehabilitation result after a cerebrovascular stroke employs a Functional Independence Measure (FIM). Some research works have studied the effects of concomitant diseases on the dynamic changes of the cognitive functions, evaluated using the combination of validated clinical scales — the Mini-Mental State Examination (MMSE), the Hospital Anxiety and Depression Scale (HADS), the Montreal Cognitive Assessment (MoCA) and the Barthel Activities of Daily Living [ADL] Index [9, 24–37] (table 3). Out of the 13 publications using the FIM, 10 were employing the total comorbidity index, while other 3 were focused on the specific concomitant diseases. Three retrospective research works were employing the Charlson index for the evaluation of

Table 1

**The table for calculating the significant comorbidities in the patient — CIRS-G
(Cumulative Illness Rating Scale-Geriatrics)**

Organs and systems	Points	Interpretation
Heart	0	Vessels Level 0: no problems. Level 1: hypertension, compensated by restriction of cooking salt and by decreasing the weight / serum cholesterol >200 mg/dl. Level 2: daily intake of anti-hypertensive drugs / single atherosclerosis symptom (claudication, vascular murmurs, transient vision loss, absence of pulse in the feet) / aortic aneurism <4 cm. Level 3: two or more atherosclerosis symptoms (see below). Level 4: surgical interventions due to vascular problems / aortic aneurism >4 cm. <i>Comments.</i> The arterial hypertension is defined as stable increase of diastolic pressure >90 mm.Hg. Absence of necessity for medication therapy — “1”; single daily intake of a drug for decreasing the BP — “2”; daily intake of two or more drugs for the control of BP or the presence of signs of hypertrophy in the left ventricle — “3”. Atherosclerosis of peripheral vessels. Presence of at least one symptom upon physical examination or confirmation by the imaging methods (for example, angiography) — “2”; the presence of two or more symptoms — “3”; if by-passing was done or required — “4”. The impaired cerebral circulation is evaluated in the nervous system section. Aneurism of the aorta: diameter <4 cm — “3”; >4 cm — “4”
Vessels	0	
Hematopoietic system (blood, vessels, bone marrow, spleen, lymphatic system)	0	
Respiratory system (lungs, bronchi, trachea from the laryngeal level)	0	
ENT-organs	0	
Upper GIT (esophagus, stomach, duodenum)	0	
Lower GIT (intestine, herniations)	0	
Liver (including bile ducts and pancreatic ducts)	0	
Kidneys	0	
Urogenital system (urinary ducts, urinary bladder, urethra, prostate gland, genitals, uterus, ovaries)	0	
Locomotor system, skin and mucosal membranes	0	
Nervous system	0	
Endocrine system / metabolic disorders and mammary glands (including infection and poisonings)	0	
Psychiatric diseases	0	
Assessment of malignant tumors	0	
Other diseases	0	

Note. The calculation table estimates the geriatric variant of the cumulative comorbidity index CIRS-G according to guideline by M.D. Miller et al., 1991 [21]. GIT — gastrointestinal tract; BP — blood pressure.

Table 2

Charlson Comorbidity Index

Points	Diseases
1	Myocardial infarction Congestive cardiac insufficiency Diseases of peripheral arteries Cerebrovascular disease Dementia Chronic lung disease Connective tissue disease Ulcerative disease Mild hepatic disease Diabetes
2	Hemiplegia Moderate or severe kidney disease Diabetes with organ abnormalities Malignant tumor without metastases Leucemia Lymphoma
3	Moderate or severe hepatic disease
6	Metastatic malignant tumors AIDS (the disease, not only the viremia)
For each 10 years of life after the age of 40 years, add 1 point: 40–49 years — 1 point, 50–59 — 2 points etc.	
Sum of points	10-year survival rate, %
0	99
1	96
2	90
3	77
4	53
5	21

Note. When calculating the Charlson comorbidity index, sum all the age points and the points of somatic diseases. AIDS — acquired immunodeficiency syndrome.

comorbidity, one used the CIRS, another one was employing the weighted Comorbidity Index (w-CI), while the Comorbidity Severity Index (ComSI) and the Complication Severity Index (CompSI) was used in one research work each. One of the research works based on the Charlson index, had a comparatively small sample ($n=58$), showing that the Charlson index was one of the several independent predictors for FIM on discharge and FIM during the further follow-up (in an average of 19.5 months) during the multivariate analysis among the groups of patients with cerebellar stroke [24]. Despite the small sample size, not less than seven variables were added to the multifactorial model. The second research included 129 patients and it has shown that the Charlson index was one of the several independent predictors of the functional

outcome, influencing on the results of FIM scores on discharge from the in-patient department [9]. Taking into consideration the fact that the Charlson index has not found its wide use in the settings of medical rehabilitation, M. Liu et al. [28] have compiled a new index — the weighted Comorbidity index (w-CI). They have compared the validity and the robustness of their index, which included the complications specific for stroke patients, but not added to the Charlson index, such as the pain in the shoulder, depression and impaired vision, to the Charlson index. When analyzing the FIM values on discharge, the weighted version of their new index, unlike the Charlson index, was the independent predictor for FIM on discharge. G. Ferriero et al. [35] have also compiled a weighted comorbidity index based on the risk factors and the factors limiting the course of medical rehabilitation due to comorbidities. This group has divided the elements of the index compiled by Liu et al. [28], into the comorbidities and the complications of stroke, assigning the scores to functional limitations caused by the comorbidity or by the complication (absence of limitations, moderate limitations and severe limitations), arranging two separate scores for the analysis — the Comorbidity Severity Index (ComSI) and the Complication Severity Index (CompSI). In this small research work, the patients without comorbidities scored by the ComSI on admission, during the rehabilitation had a higher FIM on discharge comparing to the ones having at least one concomitant disease [35]. In other research work, the Cumulative Illness Rating Scale (CIRS) in a sample of 93 patients did not show any correlation between the CIRS and the FIM on discharge [27].

A large retrospective analysis of the USA data base for the period of 5 years (864 institutions of in-patient rehabilitation) with a huge patient sample ($n=371\,211$) was devoted to evaluating the interrelation between the number of concomitant diseases and the FIM. As a result, a relation was proven between the increase in the number of concomitant diseases (an average of 7.9 concomitant diseases per patient) and the decrease in the probability of achieving or exceeding the rehabilitation objectives (the target FIM value) [31]. Another two large retrospective research works have used the data bases [30, 32] to investigate the role of diabetes severity. Both of them have reported a relation between the severity of diabetes and a lower predictable FIM on discharge in younger population, but did not find a significant interrelation for the elderly patients (older than 80 years), with this, the research works also report the statistically significantly longer

Table 3

Results of clinical studies when evaluating the rehabilitation potential depending on the comorbidity diseases

Research type	Sample number	Result	Source
Retrospective	58	CCI was an independent predictor of increased FIM on discharge	[24]
Retrospective	129	CCI was one of the several independent predictors for the functional result, determined using the FIM scale, on discharge (corrected for multiple factors)	[9]
Prospective	40	The research has shown that larger number of concomitant diseases negatively affects the final FIM values	[25]
Retrospective	2402	The research did not show clear effects of CCI values on the FIM outcomes, however, the group receiving rehabilitation therapy had better outcomes	[26]
Prospective	93	The CIRS has demonstrated the prediction of concomitant diseases, but not the changes of FIM	[27]
Retrospective	106	w-CI significantly correlated with FIM on discharge and with the duration of hospitalization	[28]
Prospective	1317	The evaluation of the individual concomitant diseases and their effects on the ADL and HADS values has demonstrated a direct negative effect of the number of concomitant diseases on the rehabilitation potential	[29]
Retrospective	135 097	Diabetes (with a large number of complications) correlated with (lower) FIM on discharge and the duration of hospitalization in the younger cohort (<60 years) with a decreasing tendency to the age of 80	[30]
Retrospective	371 211	The increase in the number of comorbidities is related to the decreased chances of achieving the FIM tasks	[31]
Retrospective	35 243	Diabetes (with a large number of complications) correlated with lower predictable FIM on discharge in the younger cohort (<80 years), but not with the duration of hospitalization	[32]
Prospective	97	The presence of several concomitant diseases significantly affects the severity of cognitive disorders acc. to the MoCA and MMSE scores with directly affecting the rehabilitation potential	[33]
Prospective	192	High comorbidity level affected the worse achieving of rehabilitation objectives when evaluating the functions of the upper limb using the ARAT score	[34]
Prospective	85	Low comorbidity level correlates with higher FIM scores on discharge	[35]
Prospective	448	Higher comorbidity level by two validated scales has shown the worst functional outcomes when using the ARAT, TCT (Trunk Control Test), MoCA/MMSE and ADL scales	[36]
Prospective	220	During the multivariate analysis, the younger age along with higher level of functioning, with the lesser number of concomitant diseases, the higher cognitive capabilities and the lesser severity of stroke was associated with higher mBI on discharge	[37]

Note. CCI — Charlson comorbidity index; FIM — Functional Independence Measure; CIRS — Cumulative Illness Rating Scale; w-CI — weighted Comorbidity index; ADL — Activity of Daily Life index; HADS — Hospital Anxiety and Depression Scale; MoCA — Montreal Cognitive Assessment; MMSE — Mini-Mental State Examination; ARAT — Action Research Arm Test; TCT — Trunk Control Test; mBI — the level of mental burnout (modified Barthel index).

in-patient treatment for the elderly individuals (older than 80 years) with more severe diabetes.

In the research work involving 1317 patients, in which data collection was conducted using the primary medical documentation (medical record of an

out-patient, form 025/u-04; statistical forms No. 12) and by means of questioning the patients, an interrelation was shown for the severity of comorbidity and the specific rehabilitation scales — Barthell, HADS and the Mini-Mental Status Score. A direct correlation was found

between the presence and the severity of concomitant diseases and the level of rehabilitation potential with the need for evaluating the comorbidity when compiling the individual plan of medical rehabilitation [29]. In other research, the Lithuanian colleagues with a small sample of patients ($n=40$) were using the FIM and MAS (Modified Ashworth Scale) scales to show the direct relationship for the decrease in the rehabilitation results and the severe comorbidity [25].

Interesting results were obtained by H.W. Morrison et al. [33] in a research with the participation of 97 patients, in which a detailed analysis was conducted of the diseases and health conditions in the patients after a history of stroke along with evaluating the status of the higher mental functions using the MoCA and MMSE scores. It was shown that the presence of several concomitant diseases significantly affects the degree of cognitive disorders and directly affects the rehabilitation potential. A quite large research work ($n=2402$) did not find any direct interrelation between the Charlson index score and the changes in the FIM scores, however, the authors themselves have noted the significant heterogeneity in the comparison group, which calls into question the obtained result [26]. In another research that included 192 patients and conducted mainly for the evaluation of the efficiency of the PREP (Predicting Recovery Potential — predicting the restoration of motor functions in the upper limb after a cerebrovascular stroke) algorithm, it was reported that the presence of significant comorbidity was associated with longer stay at the In-Patient Department and with worse functional outcomes during medical rehabilitation [34].

A large prospective research ($n=448$) by A. Finocchi et al. [36] was devoted to the automatization of evaluating the predictors of restoring the possibilities of unassisted moving and included an evaluation of the comorbidity background using the main scores — CIRS-G and Charlson index; the motor and the cognitive functions were evaluated using the validated scales, including the Barthel index, the trunk control test, the Action Research Arm Test (ARAT), the MMSE and the MoCA. As a result, a correlation was found between the higher comorbidity level and the worse functional outcomes to the moment of discharge from the In-Patient Department. In another multicenter prospective observational research [37] involving 220 patients, the authors were arranging a search of the patient assessment algorithm at the early recovery period after an episode of the CVA for the purpose of clearly defining the predictors for the functional

outcome. It was determined that comorbidity is an independent and statistically significant prognostic factor, negatively affecting the functional outcome after the intensive rehabilitation, i.e. the higher is the patient's number of concomitant diseases, the lower is the expected level of functional independence on discharge. Also a statistically significant weak negative correlation was found between the CIRS index and the mBI testing result (modified Barthel index) on discharge. After taking into account all the other important factors (age, severity of stroke, motor and cognitive functions on admission), the CIRS index has remained an independent outcome predictor.

CONCLUSION

Evaluating the comorbidities in a patient is one of the most important components of determining the rehabilitation potential after an episode of CVA, directly affecting the choice of the tactics for rehabilitation therapy and its efficiency. The analysis of literature data has shown an interrelation between the number and the severity of the concomitant diseases and the rehabilitation results. Summarizing these data, it can be concluded that the presence of a single concomitant disease such as the hypertensive disease or atrial fibrillation, is the factor, moderately limiting the rehabilitation potential, the presence of diabetes with multiple complications is the factor, significantly limiting the rehabilitation potential and the future restoring the functions, while the presence of two or more significant abnormalities, such as the combination of diabetes and atrial fibrillation, is the predictor for a significant decrease in the rehabilitation potential and for the worse outcome when using the functional independence measure (FIM). Thus, the highest value belongs to severe diabetes with multiple complications, to atrial fibrillation and to chronic cardiac insufficiency with decreased ejection fraction.

Thus, the topical issue is compiling a single unified method of determining the rehabilitation potential.

ADDITIONAL INFORMATION

Author contributions: B.B. Polyayev, data analysis, writing the manuscript; G.E. Ivanova, concept, editing; M.A. Bulatova, searching the literature sources; O.V. Fuchizhi, data processing, revision and editing the manuscript. All the authors have approved the manuscript (the version to be published) and agreed to be accountable for all aspects of the work, ensuring that questions related to the accuracy and integrity of any part of it are appropriately reviewed and resolved.

Funding sources: The article was prepared with the support of the Federal Medical-Biological Agency of Russia

Disclosure of interests: The authors declare no conflict of interests.

Statement of originality: The authors did not utilize previously published information (text, illustrations, data) in conducting the research and creating this paper.

Data availability statement: The authors state that all the available data are provided in the article and/or in the annexes to it. The initial data on the research can be provided on request.

Generative AI: Generative AI technologies were not used for this article creation.

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