DOI: 10.17816/KMJ2018-260

Pathophysiologic aspects of the development of cognitive disorders in chronic heart failure in elderly patients

M.A. Pokachalova, M.V. Silyutina

Voronezh State Medical University named after N.N. Burdenko, Voronezh, Russia

Abstract

The present literature review presents current views on pathophysiologic aspects of the formation and progression of cognitive disorders in chronic heart failure in elderly patients. Advanced age itself is an important predictor of the development of cardiovascular, neurodegenerative and other diseases. Involutive changes of cardiovascular system are known to potentiate the development of chronic heart failure. Heart failure in older people usually develops gradually. Formation of the cognitive deficit in heart disease is associated with chronic cerebral ischemia as well as a cascade of neurochemical processes occurring in the brain, eventually forming a vicious circle. Often the symptoms of cerebral ischemia due to reduced stroke volume occur much earlier than congestion signs in other organs and systems. Chronic cerebral ischemia that occurs due to violation of cerebral hemodynamics, is associated with both extracerebral and intracerebral causes, which in turn contributes to the development of chronic brain hypoxia and aggravation of cognitive dysfunction. Thus, the features of the development and course of disease in people of older age groups indicate that in geriatric practice existing diagnostic schemes are not always applicable. When observing patients of elderly and senile age with chronic heart failure, during the assessment of their condition and running diagnostic tests, special attention should be payed to the earliest detection of cognitive dysfunction signs in order to correct the patient's treatment and improve quality of life.

Keywords: chronic heart failure, chronic cerebral ischemia, cognitive dysfunction, elderly patients.

For citation: Pokachalova M.A., Silyutina M.V. Pathophysiologic aspects of the development of cognitive disorders in chronic heart failure in elderly patients. *Kazan medical journal*. 2018; 99 (2): 260–264. DOI: 10.17816/KMJ2018-260.

With a significant increase in the elderly population and in the prevalence of chronic heart failure in this group, this pathology in elderly has been recently labeled as “cardiogeriatric syndrome” [1].

Chronic heart failure is a highly prevalent pathology of the cardiovascular system and is characterized by extremely unfavorable prognosis and significant economic costs [2, 3]. The most frequent causes of chronic heart failure in elderly population include ischemic heart disease, arterial hypertension, and type 2 diabetes mellitus [4]. These diseases either alone or in combination contribute to the initiation of the cardiovascular continuum, which has fatal outcomes [2, 4].

Physiological changes in the body associated with aging contribute to the development of chronic heart failure [1, 2]. This is due to an age-induced decrease in the amount of cardiomyocytes and changes in the cardiac muscle connective tissue (including amyloid accumulation). Moreover, irrespective of the blood pressure level, age induces myocardial stiffness and moderate physiological hypertrophy, resulting in the development of ventricular diastolic dysfunction. Structural changes in valves (fibrosis and calcification) and impaired excitability and conductibility that develop with a decrease in the number of functional cells in the sinus node and cardiac conduction system can cause a decrease in systolic myocardial function [5].

In elderly patients, age-related changes and concomitant diseases often alter heart failure symptoms and objective examination findings; however, the diagnostic criteria for heart failure in the elderly are similar to that of in general population [6].

Recently, elderly patients with cardiac pathologies and with moderate to pronounced signs of intellectual and amnestic dysfunction are being examined more carefully. Old age is the strongest and the most common independent risk factor for higher cerebral (cognitive) dysfunctions [7]. With the increase in the elderly population, the number of elderly patients with cognitive disorders has also increased. Advances in studies involving the pathophysiology and neurochemistry of cognitive

For correspondence: marisanna85@mail.ru Received 10.10.2017; accepted 30.01.2018.

disorders, along with new breakthroughs in neuropharmacology, have led researchers to consider cognitive disorders as partly curable [8].

Cognitive disorders involve subjectively and/or objectively detectable, impaired, higher cerebral functions with regard to the initial individual or average, age-related, educational level and are due to the organic pathology of the brain responding various etiologies, ultimately affecting the learning efficiency and professional, household, and social activities [9]. In elderly, hemodynamic changes occur along with involution in structural and morphological features of the brain.

With age, the brain undergoes numerous, regular changes, which weaken the concentration and operative memory and are considered negligible and can be compensated by life experience [9, 10]. However, in addition to normal physiological changes, aging is often accompanied by chronic neurological diseases that lead to more pronounced cognitive disorders. Thus, age is the strongest risk factor for neurodegenerative and vascular diseases of the brain [11].

Cognitive disorders are diagnosed in patients when one or more cognitive functions of the brain, such as, memory, gnosis, speech, praxis, and intellect, deteriorate in relation to the individual norm for that patient [12]. With age, the number and density of dopamine receptors in the brain decrease, ultimately decreasing the content of dopamine in the subcortices of the brain. Consequently, in addition to motor symptoms (impoverishment mimics, bradyphrenia, stooped posture, and shuffling gait), "dopamine-sensitive" cognitive symptoms develop. Along with the age-related development of vascular diseases, the response speed decreases, difficulty in absorbing and implementing a new program of action increases, and attention level and operative memory decreases. The most significant changes occur between 45 and 60 years of age. In cerebrovascular diseases, cognitive deficiency is most commonly recorded among patients with chronic cerebral ischemia [10, 13].

Of all organs of in the body, the brain demands the highest blood flow intensity (20% of the minute volume of the blood flow). On an average, the cerebral blood flow in 20–35 year-old people amounts to 75–80 ml per 100 g medulla per minute and is reduced by 2.5–3.5 ml every 10 years, reaching 60–65 ml per 100 g medulla per minute at the age of ≥70 years. The most significant changes with regard to cerebral blood flow are noted in the frontal, temporal, and parietal regions [14].

The cerebral blood flow per minute depends on the perfusion pressure in the main arteries of the head and the resistance of the intracranial vessels. Perfusion pressure is the difference between the arterial pressure, which ensures the movement of arterial blood, and the venous pressure, providing outflow of the arterial blood. Regulation of blood flow per minute, which caters to the metabolic needs of the brain, in the absence of obstructions to the blood flow in the brain-supplying arteries and a sufficient minute volume of the heart are regulated by changes in the lumen of the intracerebral vessels. Thus, with a small decrease in the perfusion pressure, cerebral vessels expand in a compensatory manner, and the blood flow is maintained by the reduction in the resistance of cerebral vessels, both large and small. Progressive decrease in perfusion pressure leads to a decrease in the cerebral blood flow per minute. Thus, the blood flow per minute can be altered not only by lesions of the main arteries but also by changes in systemic hemodynamics, which are determined by the state of the heart and extracerebral vessels [14, 15].

Cognitive disorders develop as a consequence of cerebral vascular lesions and non-cerebral causes resulting in cerebral circulation pathologies. Among non-cerebral causes disorders of systemic hemodynamics play a major role and result in chronic insufficiency of adequate blood supply to the brain [16].

Recently, chronic heart failure has been identified as a major factor involved in the development of chronic cerebral hypoxia and ultimately in the development of cognitive dysfunction along with arterial hypertension and coronary heart disease [17]. For the pathogenesis of chronic disorders of the cerebral circulation, reflex vascular mechanisms are crucial at virtually any level of the circulatory system and the disorder of reflexogenic zones of large vessels, especially the internal carotid artery and the sinocarotid zone, which regulates an adequate ratio between intra- and extracranial pressure.

Chronic heart failure is associated with disordered sinocarotid zone, and progression of the impairment results in the zone itself participating in the formation of these conditions. In addition, both decreased and increased excitability of the carotid sinus, as well as its altered reactivity, lead to impaired cerebral circulation. Further in the course of the pathological process, the regulatory effect of carotid sinus on the cerebral blood circulation is eliminated; subsequently, the carotid sinus passively

obeys changes in the general circulation of the blood. In addition, adaptive mechanisms that protect cerebral circulation against significant fluctuations from changes in total blood pressure are impaired. Thus, a defective sinocarotid system is unable to maintain the required pressure in cerebral vessels; the pressure further decreases with cardiovascular insufficiency, thereby aggravating cerebral vascular insufficiency.

Any organic lesion of the vessel (such as atherosclerotic plaque and thrombus) can also induce pathological impulses and, subsequently, maintain the spasm condition in the neighboring arterial branches (vaso-vasal reflex). Therefore, the severity of the disorder depends mainly on the concomitant spasm of the vasculature and partly on mechanical obstructions to the blood flow. The differing etiologies of vascular lesions may result in a cerebral circulatory insufficiency in either a fully or a partially inactive vessel bed, which develops due to gap between the demand and supply of blood to the brain [18].

In people >70 years of age, atherosclerotic lesions of the extra- and intracerebral arteries of the neck and head are predominant causes for the pathogenesis of chronic cerebral circulation disorders. In such patients, the severity of the constrictive lesion of the vessel lumen along with the extension of the lesions to other vascular beds plays an important role. Additionally, in this case, the role of severe arterial hypertension as the main cause in the pathogenesis of chronic cerebral circulation disorders is reduced.

Reportedly, the number of combinations of atherosclerotic lesions of the main vessels of the neck and head with mild and moderate forms of arterial hypertension has increased. A decrease in the cardiac output or a change in the contractile function of the heart contributes to the deterioration of cerebral hemodynamics, thereby developing and aggravating the course of chronic cerebral ischemia [18, 19].

Maintaining a stable brain working capacity is associated with high energy demands. At the same time, nervous tissues have highly limited energy resources; thus, ensuring consistent high perfusion pressure is indispensable for maintaining the optimal functional activity of the brain. The driving link in the pathogenesis of cerebrovascular disorders in elderly patients can be oxygen deficiency. To ensure that the constant need of brain tissue with regard to energy substrates and oxygen is met, approximately 14% of the total circulating blood volume, corresponding to approximately 20% of the total oxygen consumed by the body, should flow through the brain,.

Hypoxia, resulting from chronic heart failure in elderly patients, aggravates cerebral circulation disorders. These disorders result in metabolic shifts, changes in oxidation-reduction processes, accumulation of under-oxidized metabolic products, and development of intra- and extracellular acidosis, capillary trophic insufficiency, and cerebral edema. On the contrary, cerebral hypoxia and ischemia disrupt the central vegetative mechanisms of blood circulation regulation, which aggravates the course of cardiac pathology, thus resulting in a vicious circle. Given these mechanisms, heart failure increases the risk of cognitive disorders by a factor of 2 [20].

Clinically, the evaluation of cognitive dysfunction should be considered as a promising way for early prediction of intellectual and amnestic disorders, which can be asymptomatic for a long time along with an underlying cardiovascular system disease.

Thus, chronic heart failure in older patients in combination with cognitive disorders represents a complex medical and social issue. The difficulty in diagnosis and the lack of clear algorithms for treating elderly patients make this problem extremely important to improve the quality and prolonging the life of elderly patients.

The authors declare no conflicts of interest on the article presented.

REFERENCES

1. *Rukovodstvo po gerontologii i geriatrii.* Pod red. V.N. Yarygina, A.S. Melent'eva. V 4 t. T. 3. Klinicheskaya geriatriya. (Guide on gerontology and geriatrics. Ed. by V.N. Yarygin, A.S. Melent'ev. In 4 vol. Vol. 3. Clinical geristrics.) Moscow: GEOTAR-Media. 2007;894 p. (In Russ.)

2. Weir R.A.P., Mcmurray J.J.V., Taylor J., Brady A.J.B. et al. Heart failure in older patients. *Br. J. Cardiol.* 2006; 13 (4): 257–266.

3. *Natsional'nye rekomendatsii VNOK I OSSN po diagnostike i lecheniyu KhSN (tretiy peresmotr).* (National RSSC and SSHF guidelines on diagnosis and treatment of CHF (revision 3).) http://medic.ossn.ru/upload/ossn_pdf/Recomend/Guidelines %20SSHF %20rev.3.01 %20 2010.pdf. (access date: 02.02.2017). (In Russ.)

4. Beckett N.S., Peters R., Fletcher A.E. et al. Treatment of hypertension in patients 80 years of age or older. *N. Engl. J. Med.* 2008; 358 (18): 1887–1898. DOI: 10.1056/NEJMoa0801369.

5. Mirzaeva B.M., Karimdzhanova G.A., Igamberdieva R.Sh. The course of chronic heart failure in the elderly. *Molodoy uchenyy.* 2017; (7): 144–149. (In Russ.)

6. Ahmed A. DEFEAT heart failure: clinical manifestations, diagnostic assessment, and etiology of

geriatric heart failure. *Heart Fail. Clin*. 2007; 3 (4): 389–402. DOI: 10.1016/j.hfc.2007.07.005.

7. Emel'yanov Yu.V. *Kognitivnye narusheniya i pozhilykh patsientov*. (Cognitive disorders in elderly patients.) http://www.nko-zdrav.ru/?action=show&id=442 (access date: 02.10.2017). (In Russ.)

8. Yakhno N.N., Zakharov V.V., Lokshina A.B. et al. *Dementsii. Rukovodstvo dlya vrachey*. (Dementia. Guide for physicians.) Moscow: MEDpress-inform. 2010; 272 p. (In Russ.)

9. Zakharov V.V., Yakhno N.N. *Narusheniya pamyati*. (Memory disorders.) Moscow: GEOTAR-Med. 2003; 150 p. (In Russ.)

10. Yakhno N.N., Zakharov V.V. Mild cognitive disorders in the elderly. *Nevrologicheskiy zhurnal*. 2004; (1): 4–8. (In Russ.)

11. Nasreddine Z.S., Phillips N.A., Bodirian V. et al. The Montreal Cognitive Assessment (MoCA): A brief screening tool for mild cognitive impairment. *J. Am. Geriatrics Society* 2005; 53: 695–699. DOI: 10.1111/j.1532-5415.2005.53221.x.

12. Babkin A.P. Cognitive disorders and their treatment with Pronoran in the clinical practice. *Psikhicheskie rasstroystva v obshchey meditsine*. 2010; (4): 36–41. (In Russ.)

13. Preobrazhenskaya I.S. Mild cognitive disorders: diagnosis and treatment. *Nevrologiya*. 2008; (1): 53–58. (In Russ.)

14. Martynov M.Yu. Therapy of chronic cerebral vascular insufficiency. *Spravochnik poliklinicheskogo vracha*. 2006; (8): 71–75. (In Russ.)

15. *Nevrologiya*. Natsional'noe rukovodstvo. (Neurology. National guide.) Ed. by E.I. Gusev, A.N. Konovalov, V.I. Skvortsova, A.B. Gekht. Moscow: GEOTAR-Media. 2009; 1049 p. (In Russ.)

16. Kotova O.V., Akarachkova E.S. Chronic cerebral ischemia: pathogenetic mechanisms and treatment principles. *Farmateka*. 2010; (8): 57–61. (In Russ.)

17. Fedorovich A.A., Soboleva G.N. Correction of cognitive impairments by Actovegin in patients with arterial hypertension and ischemic heart disease. *Effektivnaya farmakoterapiya*. 2015; (23): 2–10. (In Russ.)

18. Leonova E.V. *Patologicheskaya fiziologiya mozgovogo krovoobrashcheniya*. Uchebno-metod. posobie. (Pathologic physiology of cerebral perfusion. Study guide.) 2nd ed., revised, supplemented. Minsk: BGMU. 2007; 47 p. (In Russ.)

19. Mozhaev S.V., Skoromets A.A., Skoromets T.A. *Neyrokhirurgiya*. Uchebnik. (Neurosurgery. Study book.) 2nd ed., revised and supplemented. Moscow: GEOTAR-Media. 2009; 480 p. (In Russ.)

20. *Patofiziologiya*. Uchebnik. (Pathophysiology. Study book.) In 2 vol. Ed. by V.V. Novitskiy, E.D. Gol'dberg, O.I. Urazova. 4th ed., revised and supplemented. Moscow: GEOTAR-Media. 2009; 640 p. (In Russ.)