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Organizational and technological algorithm of primary specialized health care at cardiovascular diseases

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Abstract

Aim. To develop an algorithm for primary specialized cardiovascular care with a priority of endovascular strategy.
Methods. The study was conducted in 2018–2019 based on the Central Clinical Hospital "Russian Railways-Medicine" and 14 polyclinics in the regions of the Russian Federation. The subject of the study is cardiovascular surgeons (n=2), possessing the skills of endovascular care. The object of the study was patients (n=1018) attended regional polyclinics of the Russian Federation. Patients were divided into two groups: group A consisting of 673 patients with clinically significant atherosclerosis of the coronary, brachiocephalic and peripheral arteries and abdominal aortic aneurysm; group B consisting of 345 patients with chronic lower limb ischemia that does not require surgical treatment. The average age of patients in group A was 69±6.1 years, in group B — 63±7.2 years. There were 467 men in group A (69.4%), and 339 in group B (98.3%). An organizational and technological algorithm was developed to improve the primary specialized cardiovascular care. The results were assessed by the presence of outcomes (heart attack, stroke, bleeding, death), the availability of endovascular care and patient survival follow up 12 and 24 months. A content analysis of scientific publications on the issue under study has been performed.
Results. An organizational and technological algorithm of primary specialized cardiovascular care has been developed, including the activities of the cardiovascular surgeon, who has the skills of endovascular care and a nurse in an outpatient clinic. The implementation of the algorithm ensured continuity, 100% availability, safety and quality of cardiovascular care using endovascular technology. Outcomes are not registered in both groups. Both patient groups showed 100% one and two-year survival.
Conclusion. The developed algorithm of primary specialized cardiovascular care has provided high quality healthcare.
Keywords: primary specialized cardiovascular care, endovascular technology, cardiovascular diseases, algorithm.

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Background. Primary health care is the basis of the health system and includes measures for the prevention, diagnosis, and treatment of diseases and conditions; medical rehabilitation; pregnancy follow-up; formation of a healthy lifestyle formation; and health education of the population.

The organization of primary medical and sanitary assistance for citizens is established based on the territorial-district principle of formation of groups of people served by place of residence, work, or study in to provide access near their homes, place of work, or training facilities. Primary specialized medical care is provided by medical specialists, including those working in medical organizations that implement the objectives of the State Guarantee Program for providing free specialized care, including high-tech medical care [1].

In 1978, the international conference of the World Health Organization (WHO) in Almaty adopted a Declaration on primary health care; the availability and quality of which was defined as a key element of the goal of achieving health for all by 2000. In 2008, the WHO stated that the goals of achieving health for all by 2000 were not fully

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met, and a new WHO strategy for the 21st century, "Health 2020," was developed. In the Russian Federation, this strategy was reflected in the implementation of a priority national project, "Health," in 2006. A Federal law issued in the Russian Federation dated November 21, 2011, aimed to protect the health of citizens and develop a medical science strategy in the Russian Federation through 2025. The main goal of the new strategy was to significantly improve the health and well-being of the population, reduce health inequality, and create a sustainable human-centered health system [1,2].

The criteria for measuring the effectiveness of primary health care are reduction of the population's mortality rate (including specific causes), reduction of direct and indirect health care costs, and high quality of life for patients [3–5].

Cardiovascular diseases (CVD) are characterized by high rates of incidence and mortality and lead to significant economic losses. In the Russian Federation, inveterate obliterating diseases of the lower limb arteries affect approximately 3 million people, or 2% to 3% of the adult population. Between 10% and 50% of patients with intermittent claudication never consult a doctor before symptoms of critical ischemia develop, which threaten amputation of the limb. This is due to the lack of cardiovascular surgeons in primary health care and the low availability of primary specialized cardiovascular care (PSCC) at the regional level.

Between 40% and 60% of patients with chronic lower limb ischemia are diagnosed with coronary heart disease and atherosclerotic lesions of the brachiocephalic arteries. Annually, 140,000 to 150,000 patients in our country experience critical ischemia that leads to high amputation and loss of limbs in 30,000 to 40,000 individuals each year. This corresponds to 13.7 to 32.3 per 100,000, or 12% of the adult population.

As many as 90% of all amputations in Russia are performed above the knee. The risk of death within 30 days after high amputations can be as high as 30%, and the risk of developing myocardial infarction, acute cerebral circulatory disorders, or infectious complications is 37%. Myocardial infarction, which causes approximately 39% of deaths in the Russian Federation, is often preceded by angina. Acute disorders of cerebral circulation, the cause of which is stenotic atherosclerosis of the brachiocephalic arteries, demonstrate no previous symptoms in 70% of patients. One year after the diagnosis of critical lower limb ischemia, 25% of patients die, 30% undergo amputation, and only 45% remain alive with both limbs. After 5 years, more than 60% of patients die, primarily from the progression of CVD and the development of complications of atherosclerosis of blood vessels. Patients with diabetes have high amputations, 15 to 40 times more often, compared with patients without diabetes.

A significant part of limb amputations is performed in the surgical departments of district and city regional medical organizations with a territory of 50,000 to 100,000 thousand residents. In 80% to 90% of cases, the decision regarding the need for amputation is made by surgeons without consultation with a cardiovascular surgeon [6–8].

Economic expenses related to CVD in 2003 in the European Union countries were 169 billion euros, which corresponded to 62% of all health expenses [9, 10]. In the Russian Federation, direct expenses on the health care system in 2009 for patients with acute coronary syndrome were approximately 21 billion rubles, indirect expenses were 53.5 billion rubles, and the total economic damage resulting from acute coronary syndrome in the country for the period from 2008 to 2009 exceeded 70 billion rubles per year [11].

An aging population combined with a high level of polymorbidity due to the progressive atherosclerosis of the arteries resulted in a progressive increase in the number of patients with common CVD. This then increased the burden on the Healthcare Service, more so on the primary link, because of the increased frequency of consultations and the need for primary specialized health care. In the context of a staff shortage, the growing need for such assistance will lead to a decrease in the quality of the Healthcare Service. Restrictions on Healthcare Service financing, the high cost of high-tech inpatient care, and the low availability of X-ray endovascular care (REC) for CVD at the regional level will increase the urgency of improving primary specialized health care based on the development of safe, effective, and "lean" technologies [12–17].

In the Russian Federation, primary health care for patients with CVD is provided by cardiovascular surgeons, surgeons, cardiologists, therapists, and general practice doctors [6, 7, 13, 18]. In our country, most primary care physicians of the Healthcare Service and cardiovascular surgeons do not possess REC skills, which is most effective in the treatment of CVD, thus reducing the availability of hospital REC and the quality of health care [7, 12, 14]. Most specialists of X-ray endovascular diagnostics and treatment do not have professional training in cardiology and cardiovascular surgery and do not provide PSCC [19].

Organizers of the Healthcare Service have developed and implemented various strategies and algorithms to improve the effectiveness of care for

patients with CVD based on the modernization of primary health care, aimed at reducing resource costs for hospital care:

1) delivery of primary health care by general practice doctors [20–22], specialists of a narrow profile cardiologists [23–26], or multidisciplinary teams [27,28];

2) organization of free or controlled ambulation [29]; and

3) introduction of a three-level system of primary specialized health care, as a hospital-replacement technology [30].

Each strategy has pros and cons, both economic and clinical.

A review of 29 randomized studies of the effectiveness of the multidisciplinary strategy of primary specialized health care demonstrated its effectiveness in reducing the economic costs of providing hospital care, decreasing mortality of patients with CVD by 25%, reducing the frequency of rehospitalization for all reasons by 47%, and improving the quality of life of patients [31].

Weinberger et al presented data showing that scheduling repeated outpatient contact with patients and the medical team according to a predetermined schedule contributes to reducing the frequency of repeated hospitalizations [32].

The incidence, prevalence, and mortality associated with CVD remain high in our country. Taking into account the geographical features of the Russian Federation, negative trends in CVD, and the continuing shortage of specialized doctors, the algorithm of primary specialized REC presented in the article was developed to improve health care, and its effectiveness was evaluated. The present study aimed to improve the delivery of health care to patients with CVD based on the implementation of an organizational and technological algorithm for primary specialized REC.

Patients and Methods

The present study was conducted in 2018 and 2019. The research base was the scientific clinical center of the Joint-Stock Company "Russian Railways," Moscow (currently the Central Clinical Hospital "RZD-Meditsina"), where doctors in the Department of Vascular Surgery conducted hospital REC and outpatient clinics were available for 14 specialties in the Russian Federation.

The subjects of the present study were practicing cardiovascular surgeons (n=2) with REC skills who practiced specialized REC and PSCC.

The present study participants were 1018 patients who applied for medical care in outpatient clinics in the Russian Federation. Group A consisted of 673 patients with clinically significant coronary atherosclerosis of subcoronal (International Classification of Diseases, 10th revision [ICD-10], code I20.8), brachiocephalic (ICD-10 code I70.8), and peripheral (ICD-10 I70 code.2) arteries and aneurysm of the infrarenal segment of the aorta (ICD-10 code I71.4). Group B consisted of 345 patients with chronic arterial insufficiency of the lower limbs of the 2A–2B degree (according to the Fontaine–Pokrovsky classification) who did not require surgical treatment. The average age of patients in groups A and B was 69±6.1 and 63±7.2 years, respectively. The medical and demographic characteristics of the patients included in the present study are shown in Table 1.

There were 467 men in group A (69.4%) and 339 men in group B (98.3%). The groups were comparable in most medical and demographic indicators but not in the number of female patients.

We used free and controlled consultation for patients at the stage of providing PSCC. Free consultation was used for initial contact with the patient, assessment of the patient's condition in the event of complications of surgical treatment, and assessment of symptomatic progression or relapse of the disease. Controlled counseling was used for planned stage-by-stage continuous management of patients' health with follow-up visits after REC for 1 to 6 months, followed by the face-to-face consultation at least once every 3 months. Group B patients were followed by the face-to-face consultation once every 3 months.

When developing the tasks, the following structural stages of the organizational and technological algorithm of PSCC were differentiated.

1) Collecting complaints and results of the case history.

2) Patient history and the determination of underlying diseases and cardiovascular risk factors.

3) Research on the state of the cardiovascular system.

a. Measurement of blood pressure, rhythm, frequency, voltage, and pulse filling bilaterally.

b. Investigation of pulsation of the main arteries of the neck, abdominal aorta, and lower limb arteries at typical points (rhythm, tension, filling, presence of systolic noise).

c. Assessment of signs of heart failure (swelling of the legs and feet, their symmetry, changes in the severity of shortness of breath when dressing/undressing and changing the position of the body).

d. Assessment of the local status of the lower limbs: the presence of trophic changes and their degree, the study of turgor, temperature, humidity, color of the skin, severity of hair, active and passive movements in the joints, trophic muscles of the hip and lower leg.

Table 1. Medical and demographic characteristics of patients

Medical and demographic characteristics	Group A (n = 673)	Group B (n = 345)
Sex. male/female	467/206	339/6
Average age. years	69±6.1	63±7.2
Coronary heart disease. angina of effort. ICD-10[1] code I20.8	71	—
Atherosclerosis of the lower limb arteries (critical lower limb ischemia of the 3rd–4th degree according to Fontaine – Pokrovsky)	482	—
Atherosclerosis of the lower limb arteries (chronic lower limb ischemia of the 2A–2B degree according to Fontaine – Pokrovsky)	—	345
Aneurysm of the infrarenal aorta more than 5.5 cm in diameter	3	—
Hemodynamically significant obliterating atherosclerosis of the brachiocephalic arteries	117	—
Non-hemolytically significant obliterating atherosclerosis of the brachiocephalic arteries	338 (50.2%)	171 (49.5%)
Underlying diseases and risk factors		
Type 2 diabetes mellitus	188 (27.9%)	96 (27.8%)
Overweight	44 (6.5%)	52 (15%)
Hypertensive disease	673 (100%)	339 (100%)
Hypercholesteremic	644 (95.7%)	341 (98.8%)
Smoking	421 (62.5%)	201 (58.2%)
Hypodynamia	66 (9.8%)	12 (3.4%)
History of myocardial infarction	159 (23.6%)	71 (20.6%)
History of stroke or transient ischemic attack	17 (2.5%)	5 (1.4%)

4) Clinical laboratory examination.

a. Determination of indications for surgical treatment.

b. Commitment to the REC treatment.

c. Assessment of the need for laboratory and objective research, consultation with an endocrinologist, neurologist, and other specialists and providing the patient with recommendations for their implementation.

5) Therapy and recommendations.

a. Emergency pharmacological hypotensive therapy when registering high blood pressure during PSCC to the patient and monitoring.

b. Prescribing optimal pharmacological therapy.

c. Recommendations for the correction of risk factors and self-monitoring of laboratory and hemodynamic indicators (keeping a diary of indicators of a twofold measurement in the morning and evening of blood pressure and pulse; if necessary, we keep a diary of indicators of the level of glycemia, body weight, diuresis).

The calculation of the availability of a hospital REC was performed using the formula:

$$Ahrec = \sum/O \times 100,$$

where Ahrec (%) indicates the availability of hospital REC as a percentage, $\sum$ indicates the number of patients with established indications for surgical treatment of CVD at the stage of PSCC, and O indicates the number of patients who received hospital REC.

A nurse who was constantly involved in the PSCC treatment measured blood pressure and pulse and recorded the cardiovascular surgeon's recommendations for optimal pharmacological therapy, self-monitoring of hemodynamic parameters by the patient, glycemia level in cases with underlying diabetes mellitus, diuresis in cases of underlying heart failure and nephratony, and body weight in excess weight, as we as the frequency of repeated outpatient contacts with the doctor.

The results were evaluated by the indicator of REC availability (%), the time of REC provision from the beginning of patient contact with a doctor at the PSCC stage (1 day), and patient survival in 12 and 24 months. In group A, 1 year results were studied in 481 patients and 2 year results were studied in 342 patients; in group B, results were studied in 298 patients at 1 year and 156 patients at 2 years.

[1]ICD-10, International Classification of Diseases, 10th revision.

Table 2. Results of risk factor modification after 1 and 2 years of monitoring and frequency of achievement of efficiency endpoints

Risk factor modification	Group A		Group B	
	1 year	2 years	1 year	2 years
Correction of glycemia in type 2 diabetes mellitus, %	100	98	100	100
Weight loss, %	76	89	87	96
Blood pressure stabilization, %	100	100	100	100
Normocholesterolemia, %	100	100	100	100
Refusal of smoking, %	81	86	84	97
Hypodynamia, %	100	100	100	100
Achieving efficacy endpoint (heart attack, stroke, bleeding, death), %	0	0	0	0

We conducted a comparative assessment of the effectiveness of treatment and prevention measures after reaching the endpoints, namely, development of acute myocardial infarction, acute cerebral circulatory disorders, hemorrhagic complications, and death. We compared the groups with each other and conducted a content analysis with the existing literature. The reliability and evidence of the results obtained were accepted based on the condition of P less than 0.05.

Results and its Discussion

In the course of scientific research, an improved organizational and technological algorithm of PSCC with a priority vector for the application of X-ray endovascular technology was presented (Fig. 1). The organizational and technological algorithm of PSCC is based on a key subject, a cardiovascular surgeon who can operate surgical and X-ray endovascular technologies for treatment and diagnostics, as well as specially trained nurses. Pain, trophic changes in tissues, and impaired functions are identified as the signs of choice for the decision on a stationary REC based on a vascular center. A high adherence of doctors and patients to REC was revealed.

The present study found that the average duration of outpatient admission for both free and controlled consultation of patients did not differ significantly (14±3.5 vs 13±7 min; $P>0.95$).

When establishing indications for hospital REC at the stage of PSCC, 82% of patients (n=552) underwent a full preoperative outpatient study, 224 patients underwent a preoperative study at home, and 328 patients underwent preoperative study at the clinical and diagnostic center of the Central Clinical Hospital "RZD-Meditsina." A total of 121 patients underwent hospital examination before surgical treatment because of the low availability of diagnostic care at their place of residence.

The availability of stationary REC was 100%. The average time to provide inpatient REC from the first contact with the doctor at the PSCC stage was 3±1.75 days. The effectiveness of X-ray endovascular technology in the treatment of patients with critical lower limb ischemia, coronary heart disease, stenotic atherosclerosis of brachiocephalic arteries, and aortic aneurysm was 100%.

The patients' high commitment to maintaining health and life contributed to the effective correction of CVD risk factors in the majority of patients in both groups in terms of the monitoring and prevention of the development of final values of effectiveness (stroke, heart attack, bleeding, and death) during the first 2 years. The results of modification of risk factors for patients in groups in 1 and 2 years of the monitoring are presented in Table 2.

Continuous management of the health of patients with CVD whose complications are preventable resulted in a high survival rate for patients (100%) in the first and second years of monitoring in both groups. Patients from group B demonstrated no progression of arterial atherosclerosis for 2 years, and no surgical treatment was performed. All patients in group A and 73.5% of patients in group B followed the rules of periodic examinations without losing contact with the doctor. The quality of communication with the doctor was improved using telecommunication technologies (i.e., telephone, email, messengers, and telemedicine).

Restrictive recommendations of cardiovascular surgeons slightly reduced the quality of life of the observed patients [33]. However, patients have formed beliefs that health and life are part of regular self-control, and they are responsible for themselves. Priority application of minimally invasive X-ray endovascular treatment technology and patients' trust in doctors and nurses allowed for the creation of a professional community with the prio-

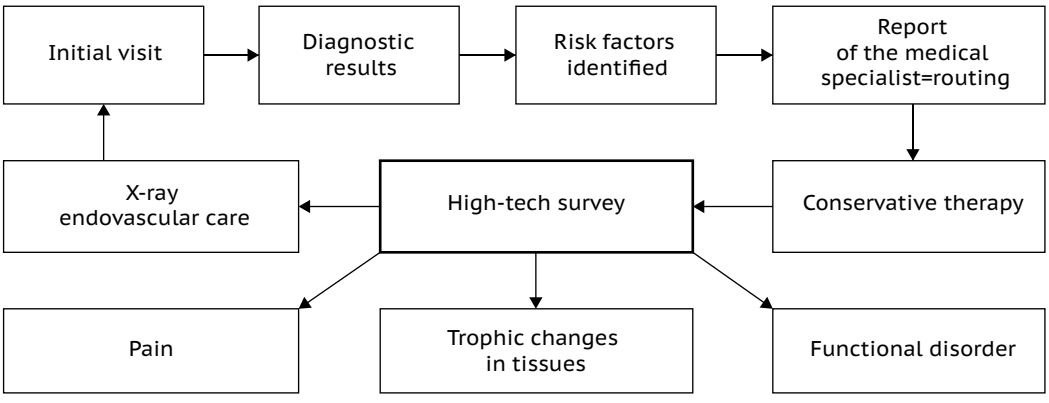

Fig.1. Organizational and technological algorithm of primary specialized cardiovascular care with a priority vector of application of X-ray endovascular technology

rities of preserving health and achieving positive trends in cardiovascular morbidity and mortality.

Practice has shown that the qualification of a nurse in the PSCC office increased significantly after 12 months, which was of great importance for the dynamic control of the patients' condition at the regional level. A regional outpatient clinic nurse could independently collect the necessary information without losing data, according to the developed algorithm, and conduct an online consultation with a cardiovascular surgeon to make a strategic decision whether to continue a conservative treatment at home, to correct CVD risk factors and optimal pharmacological therapy, or to refer the patient to the hospital for secondary hospital REC. During the second year of monitoring, 16 (4.7%) patients were referred for hospital care in connection with the progression of the atherosclerotic process and relapse of the disease. The performance outcome of the nurse in the PSCC office was 99%.

The development and implementation of an organizational and technological algorithm of PSCC with a priority strategy for the use of X-ray endovascular diagnostics and treatment were achieved with a continuous process of providing REC and an increase in the effectiveness and safety of care for patients. Improvement of cardiovascular surgery based on the development and implementation of the PSCC algorithm with the priority of REC application was aimed at preventing unjustified hospitalization of patients with CVD for conservative treatment, increasing the surgical activity of vascular surgery departments, and continuous health management of patients.

Providing primary specialized REP increases the burden on doctors and cardiovascular surgeons in hospitals. However, in the conditions of providing mainly planned inpatient cardiovascular care in the central clinical hospital "RZD-Meditsina" (98% of operations per year are planned), there is a high frequency of a resource-saving X-ray endovascular technology in the treatment of patients with CVD (100%). Primary specialized REC by cardiovascular surgeons in hospitals within the framework of internal or external cooperation promotes the formation of patient flows and development of patient routing vectors to increase surgical activity of the Department of Vascular Surgery and improves the professionalism of specialists. The result was an increase in the availability of REC for residents in regions where there is not more than a single Department of Vascular Surgery and surgeons use radiosurgical methods of diagnosis and treatment.

The algorithm of combining hospital and outpatient cardiovascular surgeons can vary depending on regional conditions, the commitment of professionals to provide specialized primary health care, the proficiency of endovascular diagnostics and treatment, the number of staff of cardiovascular surgeons, an individual plan of work of specialists, and the rotation of doctors (hospital, outpatient clinics, etc). It also depends on the head of the Department of Vascular Surgery who draws up a schedule of hospital and outpatient work.

Conclusion

The development and implementation of the algorithm for primary specialized cardiovascular care worked toward the high quality of health care.

Contribution of authors: A.U.A.: general management and coordination of the research process; R. S. G.-A.: development of the research concept, systematization, and evaluation of the results of analysis; D. I. K.: editing and generalization of results; O. V. R.: collection and primary analysis of the material and bibliography.

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