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Original article

Reprint

Open-heart surgery in elderly patients: short-term vs. long-term effects

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Abstract:
The objective of the study was to analyze in-hospital mortality and long-term survival of elderly patients who underwent open-heart surgery and met the criterion of frailty.
Materials and Methods. The study involved 266 patients over 75 years old complying with the frailty criterion (F-index ≤5). A total of 155 operations of coronary artery bypass grafting (CABG), 47 surgeries of aortic valve replacement (AVR), and 64 procedures of CABG in combination with AVR were performed. Study subjects were distributed among the groups depending on the surgery type. Postoperative complications were evaluated, and short-term and long-term outcomes were compared.
Results. In-hospital mortality was 5.3% in general group, 9.4% in CABG+AVR group, 3.9% in CABG group, and 4.2% in AVR group. There was no significant difference among the rates of in-hospital mortality between the groups (p>0.05). Long-term survival rates in general group were as follows: 98.3% for 1-year survival, 94.6% for 3-year survival, and 82.1% for 5-year survival. Type of surgery had no significant impact on the outcome (p>0.05).
Conclusion. Short- and long-term effects of CABG, AVR, and combination of CABG with AVR in the group of elderly patients who meet the criterion of frailty were characterized by low mortality and low incidence of non-fatal complications. The type of cardiac surgery and old age did not affect significantly the outcome of a surgical treatment.

Keywords: elderly, frailty, coronary artery bypass grafting, aortic valve replacement.

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Introduction

According to Russian Federal State Statistics Service, in 2019 in Russia, the elderly accounted for 5.8% of the total population nationwide. Approximately 25% of them suffer from cardiovascular diseases [1]; 15-20% of patients over 80 years old have aortic stenosis [2]. A natural increase in life expectancy inevitably leads to an increase in the number of cardiac surgery interventions in patients of the older age group. The development of myocardial protection techniques, surgical techniques, cardiopulmonary bypass and anesthesia, in turn, provides acceptable results of the open-heart surgery in this category of patients [3]. At the same time, in the absence of clear selection criteria for elderly patients, unjustified tactics are often undertaken with a tendency to conservative management. In this regard, more importance is attached to the need for preoperative geriatric assessment of patients of older age groups in case of modern cardiac surgery. Due to ongoing increase in the proportion of elderly patients, the concept of frailty is becoming progressively more relevant in the world literature. Currently, it is actively used to assess the severity of the condition and the prospects for treatment of elderly people suffering from various ailments. The prevalence of frailty in the population over 65 years old ranges from 10 to 60% [4]. It has been proven that frailty carries more than two-fold additional risk in relation to postoperative mortality [5]. It seems that the use of modern methods of preoperative assessment, taking into account frailty, should contribute to the assessment objectification relative to the effects of cardiovascular surgical treatment in elderly patients.

Objective – a comparative analysis of short-term vs. long-term effects of cardiac surgical interventions in patients over 75 years old who complied with the criteria of frailty.

Materials and Methods

The study involved patients over 75 years old who underwent AVR, CABG and combined interventions (AVR simultaneously with CABG in conditions of cardiopulmonary bypass (CPB) and myocardial anoxia) at Almazov National Medical Research Center during the period from January of 2009 through December of 2019. For all patients included in the study, F-index (frailty index) values were calculated prior to the surgery. The method for determining the F-index is described in *Table 1* [16].

The criterion for inclusion in the study was F-index values of ≤5, which complied with the presence of frailty. The study excluded patients who underwent multivalve corrections, ascending aortic replacement, off-pump CABG, transcatheter aortic valve implantation, as well as patients whose F-index was> 5. The study included 266 patients. Among them, 150 (56.4%) were men and 116 (43.6%) were women. The age in

the group averaged 81.6±1.8 years. Overall, 155 CABG operations, 47 AVR operations and 64 CABG operations in combination with AVR were performed. Patients were distributed among the groups depending on the surgery type.

We studied the clinical and functional state of patients before and after surgical treatment. In the course of analysis, standard demographic, anthropometric, anamnestic, clinical and instrumental data of patients, including comorbidity, functional class sensu NYHA classification (New York Heart Association) were recorded. To estimate predicted operative mortality, the scores on EuroSCORE II (European System for Cardiac Operative Risk Evaluation) and STS (Society of Thoracic Surgeons) scales were employed, along with taking into account types of surgical interventions, early postoperative complications and in-hospital mortality.

Table 1. Method for calculating the values of *F*-index

Scale	Components	Definition	Scoring
Potential physical performance	Balance Test	The patient is asked to stand in the semi-tandem stance for 10 seconds. Further, if the patient is able, then he/she is asked to stand in the tandem stance for 10 seconds. If the patient is unable to stand in the semi-tandem stance, then he/she is asked to stand in the normal stance for 10 seconds.	0 – feet side by side 0-9 s or unable to perform 1 – feet side by side 10 s 2 – feet in a tandem stance 0-2 s 3 – feet in a tandem stance 3–9 s 4 – feet in a tandem stance 10 s
	Chair Stand Test	The patient sits in a straight-backed chair. Ask him/her to stand up 5 times as quickly as possible with his/her arms folded across the chest; the time for 5 stand-ups is recorded (the stopwatch is stopped after the fifth rise from the chair).	0 – unable to complete 1 – >16.7 s 2 – 13.7–16.6 s 3 – 11.2–13.6 s 4 – <11.1 s
	5-Meter Walk Test	The patient is asked to walk 5 m forward; the time required for this is recorded (the stopwatch is stopped when the patient crosses the 5 m line).	0 – inability to walk 5 m 1 – >11.6 s (<0.43 m/s) 2 – 8.3–11.5 s (0.44–0.60 m/s) 3 – 6.5–8.2 s (0.61–0.77 m/s) 4 – <6.4 s (>0.78 m/s)

Each indicator is scored 0–4 points. Frailty corresponds to a total score of ≤ 5/12.

All surgical interventions in the subjects were performed using a median sternotomy. In all studied patients, CPB was carried out according to the aorta – right atrium scheme. Protection of the myocardium in 100% of patients was carried out by means of isothermic blood cardioplegia with hyperkalemic solution. In 88% of cases, the method of administration was combined: the antegrade-retrograde technique (aortic root – coronary sinus). In 32 patients with severe aortic regurgitation, solely retrograde cardioplegia was performed. The great saphenous vein and the left internal thoracic artery were used as material for CABG operations. There were no cases of either bimammary CABG, or use of radial artery.

Statistical data processing was carried out using Microsoft Excel and IBM SPSS Statistica software. All variables were tested for normality of the distribution using one-sided Kolmogorov-Smirnov test. Most of investigated indicators complied with the law of normal distribution. Statistical comparisons were performed using Student's t-test for parametric variables, or using Mann-Whitney U test for non-parametric variables. The differences between indicators were considered statistically significant at $p < 0.05$. Long-term survival was assessed via telephone interviews. The survey was conducted once – in September of 2020. We were able to establish contact with 197 patients (74%); information about remaining 69 patients (26%) could not be obtained (i.e., the contact number remained unavailable after repeated calling attempts). The collected data were analyzed using the Kaplan-Meier method. When comparing survival curves among different groups, a log-rank test was employed.

Results

The patients included in the study were characterized by the presence of multiple concomitant illnesses. for example, 51 patients (19.1%) were diagnosed with diabetes mellitus, 22 subjects (8%) with oncological diseases, 105 (39.4%) with arrythmias (atrial fibrillation), 156 (58.6%) with chronic heart failure, 38 (14.2%) with acute myocardial infarction (MI), 32 (12.4%) with chronic kidney disease, 191 (71.8%) with hypertension, and 22 subjects (8%) had a history of acute cerebrovascular accident (Table 2). 198 patients (74.4%) had no baseline myocardial contractility disorders. The left ventricular ejection fraction (LVEF) before surgery was above 55%. The mean LVEF was 59.3±11.8%. It is important to note that 15 patients (5.6%) exhibited a pronounced decrease in LVEF up to 30%, and 12 subjects (4.5%) initially showed a moderate reduction in LVEF of over 40%. The group average for NYHA functional class was initially 2.9±0.5. The mean plasma hemoglobin level prior to the surgery was 121.3±17.4 g/L. The tendency of anemia presence was accounting for high percentage of postoperative blood transfusions. The average EuroSCORE II was 6.1% [2.4; 9.8] and STS score was 6.6% [2.7; 10.5]. The average F-index was 3.1±0.9. We would like to emphasize high perceived risks of prolonged mechanical ventilation and of renal failure development (36% and 25%, respectively).

A total of 155 CABG surgeries (58.3%) were performed, and 64 CABG procedures in combination with AVR (24.1%). Solely AVR operations were performed in 47 cases (17.7%). All interventions were performed under the conditions of CPB. The average time of CPB was 104.9±32 min, the average time of aortic cross-clamping was 66.4±23.9 min (*Table 2*). In patients with aortic valve disorders, preference was given

to biological prostheses. A mechanical prosthesis was implanted in only two patients.

In the early postoperative period, the following complications were diagnosed: acute heart failure (AHF), n=10 (3.8%); perioperative MI, n=5 (1.9%); stroke, n=8 (3%); infectious complications (IC): mediastinitis, n=6 (2.3%); superficial wound infection, n=4 (1.5%); respiratory failure, n=35 (13.1%); pneumonia, n=25 (9.4%); bleeding from a postoperative wound, n=9 (3.3%); acute renal failure, n=16 (6.0%); rhythm and conduction disorders, n=44 (16.5%) (*Table 3*).

The average time spent in the intensive care unit was 2.1±1.2 days. From the presented data, it can be concluded that the incidence of complications on the part of the respiratory system and kidneys was close to the predicted values sensu STS score. The total in-hospital mortality was 5.3% (14 patients). The highest lethality was in the AVR+CABG group: 9.4% (6 patients). In the CABG group, mortality was 3.9% (6 patients); and in the AVR group, it constituted 4.2% (2 patients). At the same time, there were no significant statistical differences in terms of in-hospital mortality between the groups (p>0.05). AHF in the postoperative period was the cause of death on 8 occasions, stroke on 3 occasions, pulmonary embolism occurred in 1 patient, and IC in 2 subjects (mediastinitis). When analyzing the data in the subgroup of deceased patients, a significantly lower baseline LVEF was revealed than in the entire group (50.7±9.2% vs. 59.2±11.8%).

Table 2. General characteristics of interventions in the subjects

Patients by groups according to performed interventions	Sample size (%)	Mean time, min	
		Artificial blood circulation	Aortic cross-clamping
General group	266 (100%)	104.9±32	66.4±23.9
CABG group	155 (58.3%)	100.9±26.7	56.5±15.8
AVR group	47 (17.7%)	91.6±25.5	66.9±21.8
CABG+AVR group	64 (24.1%)	127.5±38.3	88.9±26.9

Table 3. Characteristics of complications in early postoperative period

Acute heart failure	Acute myocardial infarction	Acute cerebrovascular accident	Infectious complications	Acute renal failure	Postoperative bleeding	Heart arrhythmia and heart conduction disorders
10 (3.75%)	5 (1.87%)	8 (3%)	10 (3.75%)	16 (6%)	9 (3.3%)	44 (16.5%)

The predicted mortality sensu EuroSCORE II and STS scores in this subgroup of patients was also higher than the average for the entire pool of patients: they amounted to 8.9% [3.5; 14.3] and 9.7% [4.1; 14.8], correspondingly. The average length of stay at the cardiac surgery division for the general group was 11.1±5.9 days. The mean follow-up time for assessing long-term survival was 4.1±2.4 years. Long-term survival in the general group was as follows: a year – 98.3%, three years – 94.6%, five years – 82.1%, 10 years – 20%. The average duration of survival was 7.5±0.3 years. Long-term survival in the CABG group was as follows: a year – 99.5%, three years v 95.4%, five years v 86.5%. The average survival duration in this group was 7.8±0.4 years. Long-term survival in the AVR group was as follows: a year – 99.6%, three years – 93.1%, five years – 62.5%. The average survival time lasted 6.5±0.6 years. Long-term survival in the AVR+CABG group was as follows: a year – 93.3%, three years – 87.5%, five years – 81.9%. The average duration of survival was 7.4±0.7 years. The subjects did not experience MACE (Major Adverse Cardiac Events) within a year in 99.1% of cases, within three years in 97.1% of cases, and within five years in 89.2% of cases. Comparison of the Kaplan-Meier survival curves using the log-rank test did not show significant differences in the survival rates of patients with frailty depending on the surgery type (*Figures 1-3*).

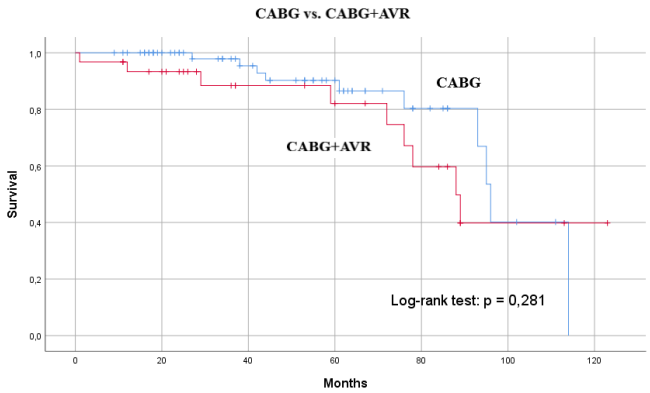

Figure 1. Comparison of survival curves across groups: CABG vs. CABG+AVR

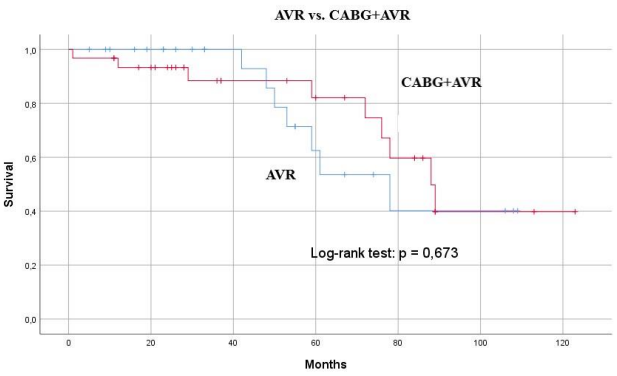

Figure 2. Comparison of survival curves across groups: AVR vs. CABG+AVR

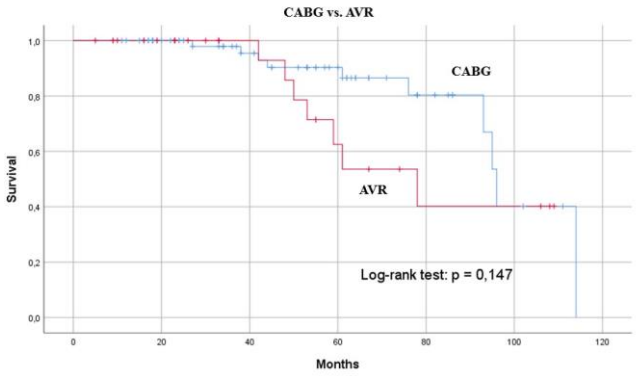

Figure 3. Comparison of survival curves across groups: CABG vs. AVR

Discussion

Coronary artery disease and degenerative aortic valve disease are among the most widespread heart diseases in elderly patients. Accordingly, cardiac surgery for this category of people is truly relevant [3, 6, 7]. However, some of the patients of this age group do not have an opportunity to receive the surgical treatment they need due to various factors. In the current Russian, American, and European guidelines for aortic stenosis treatment, old age is not a contraindication to AVR [8, 9]. Nevertheless, according to V. Lung et al. [10], in 33% of cases, healthcare professionals refuse to provide surgical treatment for aortic stenosis to elderly patients. S. Pierard et al. [11] demonstrated that about 40% of elderly people with severe aortic stenosis were treated conservatively, which, according to the authors, was associated with a poor prognosis for AVR in these patients (specifically, the twofold increase in mortality, compared with conservative therapy). At the same time, many foreign studies analyzing the AVR outcomes in the elderly, proved that this was a safe intervention with good short-term and long-term effects, significantly increasing the quality of life in this category of patients [12-13]. It is known that a significant number of elderly patients with AVR also require CABG due to the presence of hemodynamically significant stenoses of the coronary arteries. However, literature data on the nature of the effect of concomitant CABG surgery on the survival rate of elderly patients undergoing AVR are also very contradictory [12-13]. According to our research, in-hospital mortality was 5.3% in the general group, 3.9% in CABG group, 4.2% in AVR group, and 9.4% in the AVR+CABG group, which was comparable with the data of other current domestic and foreign studies on the topic [14-16]. In-hospital mortality after the AVR operation, according to foreign authors, ranged from 5.2– 6.7% [14-16] vs. 4.2% in our study. It should be noted that in the mentioned studies, conducted on old and elderly patients, the indicators of frailty were not evaluated; hence, it could be assumed that the patients included in our study were in a somewhat more severe condition, whereas the mortality rates were almost the same. As anticipated, the mortality rates in our study were significantly higher than the mortality rates in the group of younger patients (e.g., in our institution, the latter are 1.65%).

In general, the analysis of the publications on the topic over past 30 years, yields the conclusion that there is a clear trend towards a decrease in postoperative cardiac mortality in elderly patients. For example, in the early 1990s, the in-hospital mortality in AVR ranged 6-15% [3], while recent studies quoted it at the level of 2-10% [11, 13]. Foreign authors attribute this finding to the development of myocardial protection techniques, surgical techniques, CPB and anesthetic management [7]. Perhaps, an improvement in the outcomes of cardiac surgical treatment is also due to a better preoperative assessment of the patients' initial condition, which emphasizes the need for such evaluation. This hypothesis is also confirmed by the nature and frequency of postoperative complications; and the latter in our study are similar to those in domestic and foreign published sources. E.g., the study by Yu. Okamoto et al. [17] confirmed that 3.8% of 104 patients had IC in the postoperative period. In our study, such complications amounted to 3.7%. According to the observations of T. Fukuia et al. [18] and D.A. Astapova et al. [19], the frequency of stroke was 2.6 and 2.4%, respectively. In the course of analyzing our data, the frequency of postoperative stroke was found at the level of 3%. According to the studies of aforementioned authors, the incidence of MI after interventions ranged from 0 to 0.9%, which approximately matched our results (1.8%). For major postoperative complications (MI, AHF, stroke, bleeding), there were no significant statistical differences between our results and the data of other authors ($p>0.05$).

It was problematic to carry out statistical analyses of other postoperative complications due to different criteria for their diagnosis. Long-term survival rates, according to our study, did not reliably depend on the type of intervention, in contrast to the data by M. Krane et al. [20], who observed a decrease in survival in the AVR+CABG group, compared with the groups of isolated interventions. S.J. Melby et al. [12], in turn, showed the best values of short-term and long-term survival in the group of combined interventions. Consequently, the effect of combined CABG on the results of AVR in elderly patients is still controversial [12-14]. Modern endovascular methods of transcatheter implantation of prostheses provide substantial aid in the treatment of patients with aortic stenosis; however, use of these methods is often limited by the anatomy of the aortic root, absence of aortic valve calcification, discrete stenosis of the coronary arteries, mitral regurgitation, etc. Besides, currently, it is logistically impossible to perform such surgery for everyone in need within the correct time frame. Accordingly, open-heart surgeries become even more relevant over time due to general aging of the population. It is highly undesirable to deprive such patients of surgical treatment. Our data imply sufficient efficacy of open-heart interventions in elderly patients with signs of frailty, which facilitates the significant augmentation of the life span, as well as improves the quality of life in these patients.

Conclusion

The obtained data suggest that modern cardiac surgeries can provide good short-term and long-term results: this is true of CABG and AVR procedures, including the combination of both, even in a group of elderly patients who meet the criteria of frailty. Despite naturally higher mortality in the group of elderly subjects, the mentioned cardiac surgical interventions can be considered safe for this group of patients. Obviously, this becomes possible only by taking into account the most complete preoperative assessment. The presence of frailty warns the clinician that the patient has a significantly higher risk of lethal outcome and complications.

At the same time, neither old age nor frailty should be considered the reason for refusing surgical treatment of the patient: rather, they determine the need for a more detailed approach to the choice of a surgical intervention.

Conflict of interest. None declared.

References

1. Skopin II, Otarov AM, Kahkcjan PV, et al. Aortic valve replacement in old and elderly patients: Analysis of preoperative risk factors. *Complex Issues of Cardiovascular Diseases* 2018; (7): 24-35. [In Russ.]. https://doi.org/10.17802/2306-1278-2018-7-4S-24-35
2. Litmathe J, Feindt P, Kurt M, et al. Aortic valve replacement in octogenarians: Outcome and predictors of complications. *Hellenic J Cardiol* 2011; 52 (3): 211-5. https://pubmed.ncbi.nlm.nih.gov/21642069/
3. Nicolini F, Agostinelli A, Vezzani A, et al. The evolution of cardiovascular surgery in elderly patient: A review of current options and outcomes. *Biomed Res Int* 2014: 736298. https://doi.org/10.1155/2014/736298.
4. Sündermann S, Dademasch A, Praetorius J, et al. Comprehensive assessment of frailty for elderly high-risk patients undergoing cardiac surgery. *European Journal of Cardio-Thoracic Surgery* 2011; 39 (1): 33-7. https://doi.org/10.1016/j.ejcts.2010.04.013
5. Dumurgier J, Elbaz A, Ducimetiere P, et al. Slow walking speed and cardiovascular death in well functioning older adults: Prospective cohort study. *BMJ* 2009; (339): b4460–b4460. https://doi.org/10.1136/bmj.b4460
6. De Vries NM, Staal JB, van Ravensberg CD, et al. Outcome instruments to measure frailty: A systematic review. *Ageing Research Reviews* 2011; 10 (1): 104-14. https://doi.org/10.1016/j.arr.2010.09.001
7. Barreto-Filho JA, Wang Y, Dodson JA, et al. Trends in aortic valve replacement for elderly patients in the United States. *JAMA* 2013; 310 (19): 1999-2011. https://doi.org/10.1001/jama.2013.282437.
8. Otto CM, Nishimura RA, Bonow RO, et al. 2020 ACC/AHA guideline for the management of patients with valvular heart disease. *Journal of the American College of Cardiology* 2021; (143): e72-e227. https://doi.org/10.1161/CIR.0000000000000923
9. Baumgartner H, Falk V, Bax JJ, et al. ESC/EACTS Guidelines for the management of valvular heart disease. *European Heart Journal* 2017; 38 (36): 2739-91. https://doi.org/10.1093/eurheartj/ehx391
10. Iung B, Cachier A, Baron G, et al. Decision-making in elderly patients with severe aortic stenosis: Why are so many denied surgery? *European Heart Journal* 2005; 26 (24): 2714-20. https://doi.org/10.1093/eurheartj/ehi471
11. Piérard S, Seldrum S, de Meester C, et al. Incidence, determinants, and prognostic impact of operative refusal or denial in octogenarians with severe aortic stenosis. *The Annals of Thoracic Surgery* 2011; 91 (4): 1107-12. https://doi.org/10.1016/j.athoracsur.2010.12.052
12. Melby SJ, Zierer A, Kaiser SP, et al. Aortic valve replacement in octogenarians: Risk factors for early and late mortality. *The Annals of Thoracic Surgery* 2007; 83 (5): 1651-7. https://doi.org/10.1016/j.athoracsur.2006.09.068
13. Di Eusanio M, Fortuna D, De Palma R, et al. Aortic valve replacement: Results and predictors of mortality from a contemporary series of 2,256 patients. *The Journal of Thoracic and Cardiovascular Surgery* 2011; 141 (4): 940-7. https://doi.org/10.1016/j.jtcvs.2010.05.044
14. López-Rodríguez FJ, González-Santos JM, Dalmau MJ, Bueno M. Cardiac surgery in the elderly: comparison between medium-term clinical outcomes in octogenarians and the elderly from 75 to 79 years. *Revista Española de Cardiología* 2008; 61 (6): 579-88. https://pubmed.ncbi.nlm.nih.gov/18570778/
15. Likosky DS, Sorensen MJ, Dacey LJ, et al. Long-term survival of the very elderly undergoing aortic valve surgery. *Circulation* 2009; 120 (11suppl): S127-S133. https://doi.org/10.1161/CIRCULATIONAHA.108.842641.
16. Bossone E, Di Benedetto G, Frigiola A, et al. Valve surgery in octogenarians: In-hospital and long-term outcomes. *Canadian Journal of Cardiology* 2007; 23 (3): 223-7. https://doi.org/10.1016/s0828-282x(07)70749-3
17. Okamoto Y, Yamamoto K, Yoshii S. Early and late outcomes of aortic valve replacement using bioprosthetic versus mechanical valve in elderly patients: A propensity analysis. *Journal of Cardiac Surgery* 2016; 31 (4): 195-202. https://doi.org/10.1111/jocs.12719
18. Fukui T, Bando K, Tanaka S, et al. Early and mid-term outcomes of combined aortic valve replacement and coronary artery bypass grafting in elderly patients. *European Journal of Cardio-Thoracic Surgery* 2013; 45 (2): 335-40. https://doi.org/10.1093/ejcts/ezt242
19. Zheleznev SI, Isayan MV, Astapov DA, et al. The results of aortic valve replacement with a biological prosthesis, BioLAB KA/PT, in old and elderly patients. *Russian Journal of Cardiology and Cardiovascular Surgery* 2014; 7 (1): 54-9. [In Russ.].
20. Krane M, Voss B, Hiebinger A, et al. Twenty years of cardiac surgery in patients aged 80 years and older: Risks and benefits. *The Annals of Thoracic Surgery* 2011; 91 (2): 506-13. https://doi.org/10.1016/j.athoracsur.2010.10.041

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