

Impact of gender and age on long-term outcomes of isolated coronary bypass surgery

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Abstract

Aim. Search for predictors of death and analysis of long-term survival after coronary bypass surgery.

Methods. The study included 1742 patients who underwent isolated coronary bypass surgery in Emergency Hospital (Naberezhnye Chelny) between 2011 and 2019, of whom 345 (19.8%) women and 1397 (80.2%) men. The women were older: their average age was 65.89±6.98 years — versus 61.29±7.71 years for men ($p < 0.001$). The primary end point was death from any cause in the long-term postoperative period.

Results. The primary end point occurred in 170 patients (9.8% of the total sample), including 19 women and 151 men (11.2 vs. 88.8%). The average follow-up period was 43.65±27.55 months, the median follow-up period — 41 months. Both the 5-year survival rate (89% for women against 76% for men; $p = 0.042$) and overall survival rate for the entire observation period were higher in women (86% versus 74%; $p = 0.042$). Multivariate Cox regression analysis revealed that the long-term survival statistically significantly associated with age: up to 59 years [hazard ratio (HR) 0,43; confidence interval (CI) 0,28–0,65; $p < 0,001$] and aged between 60 and 69 years (HR 0,62; CI 0,41–0,9; $p < 0,018$), with gender: for female (HR 0,46; CI 0,29–0,77; $p < 0,002$) and with factor of aortic occlusion during extracorporeal circulation (HR 2,42; CI 1,13–5,17; $p < 0,022$) as well as the number of used internal thoracic arteries: one (HR 0,12; CI 0,02–0,65; $p < 0,015$) or two (HR 0,08; CI 0,01–0,95; $p < 0,045$).

Conclusion. Both 5-year and overall survival in women was higher; factors such as female gender and young age significantly influence survival in the long-term follow-up period after coronary bypass surgery, increasing it.

Keywords: CHD, Coronary heart disease, coronary artery bypass grafting, CABG, gender, long-term survival, hazard ratio.

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Background. Coronary artery bypass grafting (CABG) has been successfully used as a surgical method for the treatment of coronary heart disease since the 1960s. Until now, CABG is one of the most frequently performed cardiac procedures both in Russia and in the world [1,2].

Although CABG outcomes improve over time, differences in patient outcomes were reported because of various factors, such as sex, age, and artificial circulation (AC), that influence CABG outcomes [3].

Many studies have investigated the primary influence of various factors, such as sex, on survival after CABG; however, their results are contradictory. To our knowledge, no consensus has been established among researchers regarding the interpretation of differences in outcomes following CABG [4–6].

Aim. This study aimed to assess long-term survival in patients who underwent isolated CABG and to determine the influence of sex, age, and other factors on the risk of death after CABG.

Materials and methods. This retrospective study included all patients who underwent isolated CABG. Procedures were performed between 2011 and 2019 in an ambulance hospital in Naberezhnye Chelny, Republic of Tatarstan.

Procedures were performed under conditions with and without AC (off-pump coronary artery bypass). The selection criteria for CABG surgery without AC were as follows: coronary artery disease in one or two vessels (mainly the basins of the anterior descending and right coronary arteries) as well as standard indications for CABG without AC, including distinct atherosclerosis of the thoracic aorta with a potential threat of cerebral embo-

lism, marked dysfunction of the kidneys and lungs, and decreased systolic function of the left ventricle.

Patients with body weight < 85 kg and a lesion in one coronary artery located in the basin of the anterior descending artery, predominantly of an occlusive nature, underwent minimally invasive minimally invasive direct coronary artery bypass surgery (MIDCAB). Cases of re-CABG were not included in the study.

Surgical access included median sternotomy or, sometimes in cases of MIDCAB operation, left-sided thoracotomy in the fourth or fifth intercostal space. Surgeries under cardiopulmonary bypass conditions were performed either with cardioplegia or with conditions of “parallel” cardiac arrest [i.e., without aortic occlusion (AO) under conditions of a working heart]. One or two internal thoracic arteries (ITA), great saphenous vein, and radial artery were used as conduits.

The end point of observation was death from any cause during the long-term postoperative period (>30 days from surgery). Data on the patient's current status or death were obtained through telephone interviews or from the database of the Regional Medical Information System of the Ministry of Health of the Republic of Tatarstan. The Regional Medical Information System plays an important role for practical healthcare because it provides up-to-date information about the vital status of patients and makes it possible to further analyze results of surgical treatment and assess long-term survival and risk factors for death.

All information was collected in a database and was further analyzed. Data collection and database formation were performed using Microsoft Excel 2016 (Microsoft, USA). Statistical analysis was carried out using the IBM SPSS Statistics ver. 22 (IBM Corp. Armonk, NY, USA). The normality of distribution was assessed using the Shapiro–Wilk test. For quantitative values, the mean, standard deviation, and median were estimated. Percentages were used in categorical values. Differences between categorical variables were assessed using the χ^2 test, and differences in quantitative variables with normal and non-normal distributions were assessed using Student's t-test and Mann–Whitney test, respectively.

Long-term survival in male and female patients who underwent different types of isolated CABG (CABG with AC versus CABG without AC) at 3, 5, and 7 years was assessed using life tables.

The cumulative survival function for the whole observation period was assessed using the method of multiplier estimation with a graphical reflection in the form of survival curves according to Kaplan–Meier. Significant differences in survival

Table 1. Distribution of patients by type of surgery and sex

Surgery	Total	Male	Female
CABG with AC	1525	1213	312
CABG without AC (OPCAB)	181	151	30
CABG without AC (MIDCAB)	36	33	3
Total	1742	1397	345

Note: CABG, coronary artery bypass grafting; AC, artificial circulation; OPCAB, off-pump coronary artery bypass; MIDCAB, minimally invasive direct coronary artery bypass surgery.

Table 2. Age distribution of patients by sex

Age group	Total	Male, abs. (%)	Female, abs. (%)
< 59 years	651	593 (42.4)	58 (16.8)
60–69 years	786	605 (43.3)	181 (52.5)
≥70 years	305	199 (14.2)	106 (30.7)
Total	1742	1397	345

between groups were assessed using a log-rank test. The mean life expectancy (non-lethal outcome), probability of survival, or non-lethal outcome was calculated. A risk proportional model, Cox regression, with forced entry of all variables, was used to assess risk factors. Differences with $p < 0.05$ were considered significant.

Results. Of 1788 CABG cases, 39 hospital deaths were excluded in the analysis. Seven patients were further excluded because their current vital states were unknown. Data on the current status of patients who underwent 1742 CABG were available.

As regards distribution of the types of surgeries, there were 1525 cases of CABG with AC, 181 cases of CABG without AC with access through sternotomy, and 36 cases of CABG without AC with access through left-sided thoracotomy (MIDCAB) (Table 1).

Of the 1742 patients, 345 (19.8%) were female and 1397 (80.2%) were male. Female patients were older than male patients at the time of the surgery: the average ages of the female and male patients were 65.89 ± 6.98 years and 61.29 ± 7.71 years, respectively. The difference was significant ($p < 0.001$). The distribution of patients by age and sex is shown in Table 2.

The male and female patients did not differ in terms of the revascularization index in the general population (2.69 versus 2.62, $p = 0.252$). However, the revascularization index was higher during surgeries under cardiopulmonary bypass in male patients (2.91 versus 2.77), which was significant

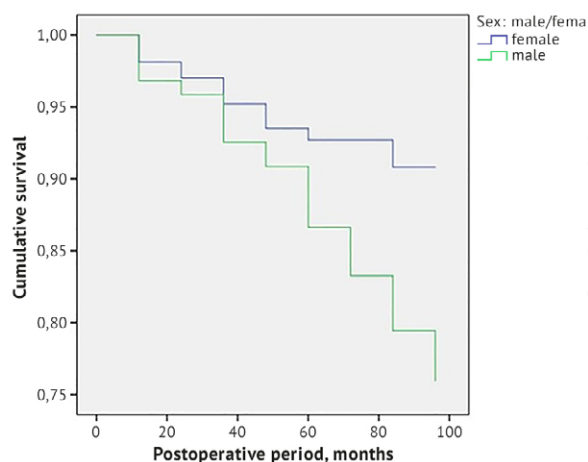


Fig. 1. Long-term survival rate by sex after 3, 5, and 7 years of follow-up

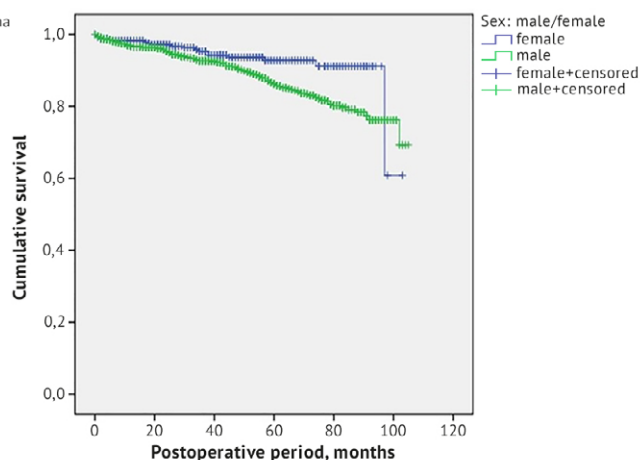


Fig. 2. Cumulative survival curve by sex

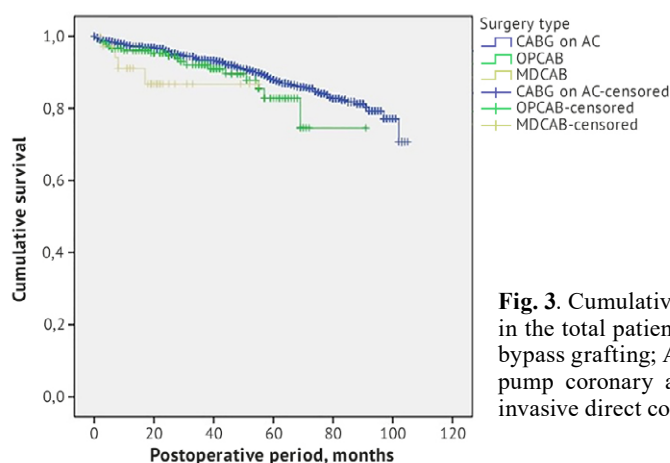


Fig. 3. Cumulative survival chart for types of surgeries in the total patient population. CABG, coronary artery bypass grafting; AC, artificial circulation; OPCAB, off-pump coronary artery bypass; MIDCAB, minimally invasive direct coronary artery bypass surgery.

($p = 0.015$). In surgeries without AC, the revascularization indices in male and female patients were 1.24 and 1.18, respectively, and no significant difference was noted ($p = 0.679$). The frequency of ITA use in male and female patients was $> 90\%$, but was not significantly different ($p = 0.761$).

During a long-term follow-up period, 170 (9.8%) patients died, including 19 (11.2%) female and 151 (88.8%) male patients. The longest observation period was 105 months, and the shortest was 2 months. Patient's status was assessed on May 18, 2020. The average follow-up period in the general sample was 43.65 ± 27.55 months, and the median follow-up was 41 months.

Life tables were used to obtain data on the 5-year survival of the general sample of patients: it was higher in female patients with 89% than in male patients with 76% ($p = 0.042$), which is clearly shown in Fig. 1.

Depending on various factors, survival was assessed both in the general population of patients and in two cohorts of patients divided by sex. The

following factors were analyzed: age, sex, AC, aortic clamping (AC), revascularization index, conduit type, ITA use, and type of surgery.

The difference in the long-term survival between the analyzed groups was significant depending on age ($p = 0.002$), sex ($p = 0.01$; Fig. 2), AO ($p = 0.008$) during surgeries with AC, and type of surgery ($p = 0.051$).

From the analysis of survival by type of surgery, all patients who underwent CABG with AC have better survival than those who underwent CABG without AC and MIDCAB (Fig. 3). The result of the log-rank test was 0.051, which was quite near the level of significance of 0.05; moreover, if we carry out the Breslow ($p = 0.042$) and Taron-Vair ($p = 0.045$) tests, results will indicate significant differences in survival among types of surgeries, which is confirmed by the curves on the corresponding graph.

However, when comparing all patients who had comparable revascularization index (≤ 2), their survival after CABG without AC did not significant-

Table 3. Cumulative assessment of survival depending on factors in the total sample of patients and patients grouped by sex

Group	Average life expectancy. months	95% CI	Standard error	p
Sex				
Female	95.24	91.34–99.14	1.99	0.01
Male	92.23	90.35–94.12	0.96	
Age				
≤59 years	95.04	92.79–97.3	1.15	0.02
60–69 years	92.77	90.22–95.33	1.3	
≥70 years	84.57	80.18–88.95	2.38	
AO at AC				
Without AO	69.53	60.24–78.82	4.74	0.008
With AO	93.98	92.26–95.69	0.87	
Male age				
≤ 59 years	94.89	92.51–97.27	1.21	<0.001
60–69 years	91.11	88.11–94.11	1.53	
≥70 years	81.18	75.59–86.78	2.85	
AO at AC in male participants				
Without AO	64.97	54.06–75.89	5.57	0.006
With AO	93.07	91.1–94.99	0.99	
Use of ITA in male participants				
Without ITA	70.22	63.96–76.48	3.19	0.013
With ITA	92.75	90.85–94.66	0.97	

Note: CI, confidence interval; AO, aortic occlusion; AC, artificial circulation; ITA, internal thoracic artery.

ly differ from patients who underwent CABG with AC ($p = 0.874$). Moreover, no difference was found in the survival with analysis of the same parameters in the context of sex (men, $p = 0.662$; women, $p = 0.0861$).

In the analysis of the long-term survival within a group of male and a group of female patients, depending on various factors, long-term survival was significantly influenced by age in male patients ($p = 0.001$), OA in cardiopulmonary bypass in male patients ($p = 0.006$), and use of ITA in male patients ($p = 0.013$).

Analysis of survival both between groups and within groups, depending on other factors, did not show significant difference (Table 3).

To determine the risk factors for mortality in the long-term follow-up period following isolated CABG, survival analysis was performed using the Cox regression method by creating univariate and multivariate models.

Of all the analyzed factors, the Cox regression method for univariate analysis was used to select those that present a significant difference in survival outcomes between the groups: age, sex, type of surgery, OA during cardiopulmonary bypass,

and use of ITA. All of the above factors improved the base model without predictors that had a positive effect on the predictive ability of the model. All variables were selected for the Cox multivariate regression analysis.

In the univariate and multivariate Cox analyses, long-term survival was significantly influenced by age 59 years, age 60–69 years, female sex, AO in cardiopulmonary bypass, and CABG with AC in the univariate analysis as well as the use of one or two ITA in the multivariate analysis.

Thus, patients aged 59 years had reduced risk of death by 2.07 times, or 52%, in the univariate analysis and 2.32 times, or 57%, in the multivariate analysis. Patients aged 60–69 years had reduced risk of death after CABG by 1.54 times, or by 35%, in the univariate analysis and by 1.6 times, or by 40.7%, in the multivariate analysis. The female sex reduced the risk of death by 1.85 times, or by 46%, in the univariate analysis and 2.18 times, or by 54%, in the multivariate analysis. Further results of univariate and multivariate Cox analyses are shown in Table 4.

Discussion. In this study, no significant difference was found in the immediate results of CABG

Table 4. Results of univariate and multivariate Cox regression analyses

Parameters	Univariate Cox regression analysis			Multivariate Cox regression analysis		
	HR	95% CI	p	HR	95% CI	p
Age	—	—	0.03	—	—	<0.001
≤59 years	0.483	0.319–0.730	0.01	0.43	0.279–0.646	<0.001
60–69 years	0.649	0.441–0.954	0.028	0.624	0.414–0.902	0.018
Sex, female	0.538	0.334–0.867	0.01	0.458	0.292–0.768	0.002
Without AO at AC	2.563	1.25–5.258	0.008	2.421	1.133–5.172	0.022
Use of one ITA	0.34	0.079–1.464	0.148	0.116	0.02–0.653	0.015
Use of two ITA	0.122	0.11–1.343	0.86	0.085	0.008–0.952	0.045
CABG on AC	0.352	0.129–0.961	0.042	0.585	0.159–2.15	0.419

Note: HR, hazard risk; CI, confidence interval; AO, aortic occlusion; AC, artificial circulation; ITA, internal thoracic artery; CABG, coronary artery bypass grafting.

and female patients showed higher hospital mortality. This is confirmed by the data of large meta-analyses carried out in the first decade of this century [7, 8]. It is reasonable that female sex as an independent predictor of death is included in the scale of risks of cardiac surgery, i.e., EuroSCORE 1 and 2 [9].

Since the early 2000s, the focus of research has shifted toward comparing long-term survival outcomes. Guru (2004) reported that female patients had comparable or better long-term survival rates than male patients. Other researchers have generated conflicting conclusions about the influence of sex [6].

In our analysis of literature data over the past decade, we came across a small number of high-quality investigations, such as meta-analyses on the results of long-term survival after CABG. Thus, in a 2013 meta-analysis, which included 20 studies and 966,492 patients, Alam et al. showed that the mortality rate in girls remains high compared with that of boys aged 1 year (2.55% versus 1.95%; $p < 0.0001$) at 5-year observations (9.26% versus 8.16%; $p < 0.0001$). The 10-year mortality (data from one study) was also higher in female patients than in male patients (14.78% versus 12.76%) [10].

In 2014, the results of IMAGINE, an international multicenter, randomized, double-blind, placebo-controlled study, were published, which assessed the difference in long-term results after CABG by sex. This study included 2,553 patients, and more female patients reached the endpoint of observation (such as death, myocardial infarction, acute cerebrovascular accident, relapse of angina pectoris, myocardial revascularization, and congestive chronic heart failure) than male patients (18% versus 12%, $p = 0.007$) [11].

However, later studies presented opposite results, i.e., women show better or comparable long-term survival, or female sex is not a risk factor for death.

In a study performed in Beijing, Wang et al. (2016) analyzed 35,173 patients and reported that the 3-year mortality was significantly higher in female patients (10.2%) than in male patients (7.3%) ($p < 0.0001$). However, the Cox multivariate regression analysis showed that female sex is not an independent risk factor of long-term mortality (risk ratio [RR] 1.294; confidence interval [CI] 0.955–1.755, $p = 0.096$), while age, history of myocardial infarction, and surgery under cardiopulmonary bypass were significantly associated with long-term mortality. In the same study, two cohorts of patients divided by sex after the propensity score matching did not show a significant difference in the 3-year mortality (9.1% in female patients versus 8.2% in male patients; $p = 0.2608$) [3].

Nicolini et al. (2016) analyzed 7308 patients and presented independent risk factors for 5-year mortality. In the Cox multivariate regression analysis, female sex was not associated with and was not an independent predictor of death in the long-term follow-up period – in contrast to factors such as age 70–80 years, age >80 years, chronic lung disease, blood creatinine level >2 mg/dL, ejection fraction 30%–50%, and diabetes mellitus [12].

Hessian et al. (2018) performed a systematic review and provided data from the care database of patients with cardiac conditions on 52,425 patients who underwent CABG surgery. Baseline analysis showed that the increase in the risk of death in women is limited to the 1st year of follow-up (RR 1.44; confidence interval 1.29–1.61; $p = 0.02$); after 1 year of follow-up, the risk of death did not increase (RR 0.89; CI 0.78–1.02; $p = 0.06$) and

became equivalent to the results of male patients after 4 years. Other long-term survival outcomes after 3, 5, and 10 years revealed no difference in mortality in patients of different sex [13].

Finally, Nuru et al. (2019) analyzed 4044 patients and reported no difference in long-term survival at 1, 5, and 10 years depending on sex ($p = 0.74$); however, the difference was found in the multivariate analysis, i.e., women showed better survival (RR 0.73; confidence interval 0.6–0.9; $p = 0.0037$) [14].

In the present study, we found that female patients had better long-term survival after CABG than male patients. These results, together with the presented background data, show that findings of researchers regarding the difference in the long-term survival in patients of different sexes remain controversial.

In our study, female patients were significantly older (65.89 ± 6.98 years for women versus 61.29 ± 7.71 years for male patients; $p < 0.001$) than male patients, and this may affect survival, both short term and long term. The results of our study can, perhaps, be partially explained by the longer life expectancy of women in the general population.

Most researchers have shown that female patients have a higher degree of comorbidity. This often leads to an explanation of the reasons for the differences between male and female patients [10,13].

Findings of many studies have indicated that women have smaller body surface area and smaller diameter of the coronary arteries, so it is technically difficult to perform bypass grafting of target coronary arteries with such a reduced diameter [13, 15], which entails “incomplete” myocardial revascularization. “Complete” myocardial revascularization has a positive effect on a favorable prognosis in patients who underwent surgery [16,17]. Thus, a 2013 meta-analysis by Garcia et al. in patients with complete revascularization reported a decrease in mortality, the frequency of myocardial infarction, and the need for repeated revascularization in the long-term follow-up period compared with patients who did not undergo complete revascularization [18].

Another scientific study in 2013 by Farooq et al., where a post hoc analysis of the SYNTAX study was performed, suggests that anatomically incomplete myocardial revascularization results in a worse prognosis of patients who underwent CABG and percutaneous coronary intervention. Patients with incomplete coronary revascularization had a significantly higher 4-year mortality rate, a more frequent need for repeated revascularization, a higher incidence of stent thrombosis, and

a lower freedom from major cardiovascular adverse events [19].

In our study, female patients had a lower revascularization index during surgeries under cardiopulmonary bypass (2.77 versus 2.91; $p = 0.015$), which, in our opinion, indicates the frequency of performing incomplete or insufficient myocardial revascularization during CABG in women.

This study has a number of limitations. First, the endpoint of observation was death from all causes; however, along with cardiac causes, with a high degree of probability, the cause of death could be a competing pathology (e.g., cancer) and/or exacerbation of existing underlying chronic diseases. Second, the data set for analysis was limited. The clinical profile of patients and data from laboratory and instrumental studies were not taken into account. The inclusion of these data would allow us to draw conclusions about the deeper reasons for the differences in the long-term survival in patients of different sexes. We do not aim to give a definitive answer and put an end to this question, but our study can contribute to replenishing the general knowledge base about long-term survival after CABG. Understanding the influence of sex, age, and other factors on outcomes after CABG is of great importance for choosing the optimal surgical strategy and techniques of patient management.

CONCLUSIONS

1. Both the 5-year and overall cumulative survival rates for the entire follow-up period were higher in female patients (86%) than in male patients (74%; $p = 0.042$).

2. The younger the patient at the time of surgery, the higher the long-term survival rate ($p = 0.02$) both in the general cohort of patients and among male patients ($p = 0.001$).

3. A significant effect on long-term survival, reducing the risk of death, is exerted by the following factors: female sex (decrease in the risk of death by 2.18 times), younger age (decrease in risk by 2.32 times), use of ITA (one or two ITA reduces the risk by 8.62 and 11.76 times, respectively), surgery under cardioplegic conditions with AC (reducing the risk of death by 2.42 times), and other factors do not have a significant effect on long-term survival.

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REFERENCES

1. Kolessov V.I. Mammary artery-coronary artery anastomosis as method of treatment for angina pectoris. *J. Thorac. Cardiovasc. Surg.* 1967; 54 (4): 535–544. DOI: 10.1016/s0022-5223(19)43061-4.
2. Favaloro R.G., Effler D.B., Cheadvechai C., Quint R.A., Sones F.M.Jr. Acute coronary insufficiency (impending myocardial infarction and myocardial infarction): surgical treatment by the saphenous vein graft technique. *Am. J. Cardiol.* 1971; 28 (5): 598–607. DOI: 10.1016/0002-9149(71)90104-4.
3. Wang J., Yu W., Zhao D., Liu N., Yu Y. In-hospital and long-term mortality in 35,173 Chinese patients undergoing coronary artery bypass grafting in Beijing: Impact of sex, age, myocardial infarction, and cardiopulmonary bypass. *J. Cardiothorac. Vasc. Anesth.* 2017; 31 (1): 26–31. DOI: 10.1053/j.jvca.2016.08.004.
4. Koch C.G., Khandwala F., Nussmeier N., Blackstone E.H. Gender and outcomes after coronary artery bypass grafting: a propensity-matched comparison. *J. Thorac. Cardiovasc. Surg.* 2003; 126 (6): 2032–2043. DOI: 10.1016/s0022-5223(19)43061-4.
5. Saxena A., Dinh D., Smith J.A., Shardey G., Reid C.M., Newcomb A.E. Sex differences in outcomes following isolated coronary artery bypass graft surgery in Australian patients: analysis of the Australasian Society of Cardiac and Thoracic Surgeons cardiac surgery database. *Eur. J. Cardio-Thorac. Surg.* 2012; 41 (4):755–762. DOI: 10.1093/ejcts/ezr039.
6. Guru V., Fremes S.E., Tu J.V. Time-related mortality for women after coronary artery bypass graft surgery: a population-based study. *J. Thorac. Cardiovasc. Surg.* 2004; 127 (4): 1158–1165. DOI: 10.1016/j.jtcvs.2003.12.008.
7. Nalysnyk L., Fahrback K., Reynolds M.W., Zhao S.Z., Ross S. Adverse events in coronary artery bypass graft (CABG) trials: a systematic review and analysis. *Heart.* 2003; 89 (7): 767–772. DOI: 10.1136/heart.89.7.767.
8. Takagi H., Manabe H., Umemoto T. A contemporary meta-analysis of gender differences in mortality after coronary artery bypass grafting. *Am. J. Cardiol.* 2010; 106 (9): 1367. DOI: 10.1016/j.amjcard.2010.07.019.
9. Roques F., Nashef S.A., Michel P., Gauducheau E., de Vincentiis C., Baudet E., Cortina J., David M., Faichney A., Gabrielle F., Gams E., Harjula A., Jones M.T., Pintor P.P., Salamon R., Thulin L. Risk factors and outcome in European cardiac surgery: analysis of the EuroSCORE multinational database of 19,030 patients. *Eur. J. Cardiothorac. Surg.* 1999; 15 (6): 816–822; discussion 822–823. DOI: 10.1016/s1010-7940(99)00106-2.
10. Alam M., Bandiali S.J., Kayani W.T., Ahmad W., Shahzad S.A., Jneid H., Birnbaum Y., Kleiman N.S., Coselli J.S., Ballantyne C.M., Lakkis N., Virani S.S. Comparison by meta-analysis of mortality after isolated coronary artery bypass grafting in women versus men. *Am. J. Cardiol.* 2013; 112 (3): 309–317. DOI: 10.1016/j.amjcard.2013.03.034.
11. Den Ruijter H.M., Haitjema S., van der Meer M.G., van der Harst P., Rouleau J.L., Asselbergs F.W., van Gilst W.H. Long-term outcome in men and women after CABG; results from the IMAGINE trial. *Atherosclerosis.* 2015; 241 (1): 284–288. DOI: 10.1016/j.atherosclerosis.2015.02.039.
12. Nicolini F., Vezzani A., Fortuna D., Contini G.A., Pacini D., Gabbieri D., Zussa C., De Palma R., Gherli T. Gender differences in outcomes following isolated coronary artery bypass grafting: long-term results. *J. Cardiothorac. Surg.* 2016; 11 (1): 144. DOI: 10.1186/s13019-016-0538-4.
13. Hessien R., Jabagi H., Ngu J.M.C., Rubens F.D. Coronary surgery in women and the challenges we face. *Can. J. Cardiol.* 2018; 34 (4): 413–421. DOI: 10.1016/j.cjca.2018.01.087.
14. Nuru A., Weltzien J.A.H., Sandvik L., Tønnessen T., Bjørnstad J.L. Short- and long-term survival after isolated coronary artery bypass grafting, the impact of gender and age. *Scand. Cardiovasc. J.* 2019; 53 (6): 342–347. DOI: 10.1080/14017431.2019.1646430.
15. Гуревич М.А., Мравян С.Р., Григорьева Н.М. Ишемическая болезнь сердца у женщин. *Трудный пациент.* 2006; 4 (12): 5–11. [Gurevich M.A., Mravyan S.R., Grigor'eva N.M. Ishemicheskaya bolezn' serdtsa u zhen-shchin. *Trudnyy patsient.* 2006; 4 (12): 5–11. (In Russ.)]
16. Neumann F.J., Sousa-Uva M., Ahlsson A., Alfonso F., Banning A.P., Benedetto U., Byrne R.A., Collet J.P., Falk V., Head S.J., Jüni P., Kastrati A., Koller A., Kristensen S.D., Niebauer J., Richter D.J., Seferovic P.M., Sibbing D., Stefanini G.G., Windecker S., Yadav R., Zembala M.O.; ESC Scientific Document Group. 2018 ESC/EACTS Guidelines on myocardial revascularization. *Eur. Heart J.* 2019; 40 (2): 87–165. DOI: 10.1093/eurheartj/ehy394.
17. 2018 ESC/EACTS guidelines on myocardial revascularization. *Russian Journal of Cardiology.* 2019; (8): 151–226. (In Russ.) DOI: 10.15829/1560-4071-2019-8-151-226.
18. Garcia S., Sandoval Y., Roukoz H., Adabag S., Canoniero M., Yannopoulos D., Brilakis E.S. Outcomes after complete versus incomplete revascularization of patients with multivessel coronary artery disease: A meta-analysis of 89,883 patients enrolled in randomized clinical trials and observational studies. *J. Am. Coll. Cardiol.* 2013; 62: 1421–1431. DOI: 10.1016/j.jacc.2013.05.033.
19. Farooq V., Serruys P.W., Garcia-Garcia H.M., Zhang Y., Bourantas C.V., Holmes D.R., Mack M., Feldman T., Morice M.C., Stahle E., James S., Colombo A., Diletti R., Papafaklis M.I., de Vries T., Morel M.A., van Es G.A., Mohr F.W., Dawkins K.D., Kappetein A.P., Sianos G., Boersma E. The negative impact of incomplete angiographic revascularization on clinical outcomes and its association with total occlusions: The SYNTAX (Synergy Between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery) trial. *J. Am. Coll. Cardiol.* 2013; 61: 282–294. DOI: 10.1016/j.jacc.2012.10.017.