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Association of Cardiovascular Disease With Hospital Mortality in COVID-19 Patients

Aim	To evaluate the relationship between the in-hospital mortality of patients with COVID-19 and the history of cardiovascular disease (CVD) using data from the Russian registry of patients with COVID-19.
Material and methods	This study included 758 patients with COVID-19 (403 men, 355 women) aged from 18 to 95 years (median, 61 years), successively hospitalized in the COVID hospital of the Chazov National Medical Research Center of Cardiology from April through June 2020. Death predictors were studied using single- and multivariate regression analyses with the SPSS Statistics, Version 23.0 software.
Results	During the stay in the hospital, 59 (7.8%) patients with COVID-19 died, 677 (89.3%) were discharged, and 22 (2.9%) were transferred to other hospitals. The univariate regression analysis showed that the increase in age per decade was associated with a 92% increase in the risk of death [relative risk (RR), 1.92; 95% confidence interval (CI), 1.58–2.34; p <0.001], and an increase in the number of CVDs increases the risk of death by 71% (RR 1.71; 95% CI 1.42–2.07; p<0.001). The presence of one or more CVDs or specific diseases [atrial fibrillation, chronic heart failure (CHF), ischemic heart disease, myocardial infarction, history of cerebrovascular accidents], as well as diabetes mellitus were associated with a higher risk of fatal outcome during the hospitalization for COVID-19. The presence of any CVD increased the risk of in-hospital death by 3.2 times. However, when the model was adjusted for age and sex, this association lost its strength, and only the presence of CHF was associated with a 3-fold increase in the risk of death (RR, 3.16; 95% CI, 1.64–6.09; p=0.001). Age was another independent predictor of death (RR, 1.05; 95% CI, 1.03–1.08; p < 0.001).
Conclusion	A history of CVD and the CVD number and severity are associated with a higher risk of death during the hospitalization for COVID-19; the independent predictors of in-hospital death are an age of 80 years and older and CHF.

Keywords	COVID-19; cardiovascular diseases; death; in-hospital mortality
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Introduction

The COVID-19 pandemic affected more than 420 million people and caused more than 6 million deaths worldwide [1]. During the first wave of the pandemic, physicians and researchers focused mostly on etiotropic, pathogenetic treatment strategies for lung tissue damage and strategies for restoring respiratory system functions in acute respiratory distress syndrome. The relationship between viral infection and cardiovascular diseases (CVDs) and their pathophysiological mechanisms – such as elevated platelet activity, high risk of thrombosis, and endothelial dysfunction [2] —became more widely discussed later [3]. Several observational studies conducted around the globe established the high comorbidity of COVID-19 combined with CVDs and the high vulnerability of cardiovascular patients to severe course and death of COVID-19 [4–7]. The results obtained in various populations show heterogeneity, which may be due to specific features of medical care and socioeconomic factors, among other things. Scientific research in this field is of great interest, as it enables the most comprehensive examination of the factors related to the adverse outcomes of COVID-19.

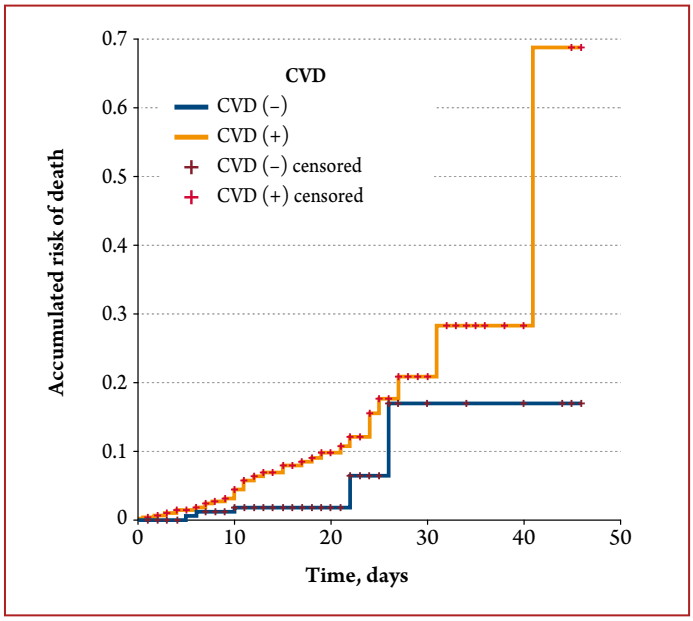
Objective

Examine the correlation between the in-hospital mortality of COVID-19 patients and their history of cardiovascular diseases based on data from the Russian COVID-19 Patient Registry.

Material and Methods

The study included 758 patients (403 males and 355 females, 18 to 95 years old, median age 61 years) who were

Central illustration.
Accumulated risk of in-hospital mortality of COVID-19 patients depending on the presence or absence of CVDs (Kaplan–Meier survival analysis; n = 745)



consecutively admitted to the COVID-19 hospital of the National Medical Research Center of Cardiology named after Ac. E. Chazov for COVID-19 between April and June 2020. Nearly 40% of patients admitted to hospital were over 65 years of age (Table 1). There were more male patients in the 20–29, 30–39, and 40–49 age groups than female patients (p = 0.043, p = 0.045, and p = 0.019, respectively), while women dominated the 80–89 age group (p = 0.010; Figure 1).

Statistical data processing was conducted in SPSS Statistics version 23.0 (SPSS Inc., USA). The results are presented as the medians and interquartile range (25th and 75th percentiles; Me [25%; 75%]). Qualitative ordinal variables are also presented as Me [25%; 75%]; qualitative nominal variables are expressed as rates. The two-tailed Fisher's exact test, Pearson's chi-squared test, or the Mann–Whitney U-test were used to compare the groups. To analyze the relationships between the variables, binary logistic regression with the calculation of odds ratio (OR) and 95% confidence interval (CI), or the Cox proportional hazards model with hazard ratio (HR) and 95% CI, were used. A multivariate regression analysis (Cox proportional hazards model) was carried out to clarify the significance of CVDs as independent predictors of in-hospital death. The analysis included age (as an extensive variable); sex; CVDs: arterial hypertension (AH), coronary artery disease (CAD) (angina pectoris, myocardial infarction (MI), myocardial revascularization), atrial fibrillation (AF), chronic heart failure (CHF), peripheral arterial disease, history of cerebrovascular accident (CVA); and diabetes mellitus (DM). The method of direct step-by-step inclusion of variables was used; the missing values were removed line-by-line. Kaplan-Meier survival analysis was performed. The survival curves were compared using a log-rank test. The differences were statistically significant at a two-tailed level of significance of $p < 0.05$.

Results

Patients with COVID-19 spent in hospital from a few hours to 46 days with a median of 15 [2; 19] days. Characteristics of patients hospitalized with COVID-19 are provided in Table 1.

The median body mass index (BMI) was indicative of overweight with the prevalence of overweight and obese

Figure 1. Distribution of patients hospitalized with COVID-19 by age and sex (n = 758)

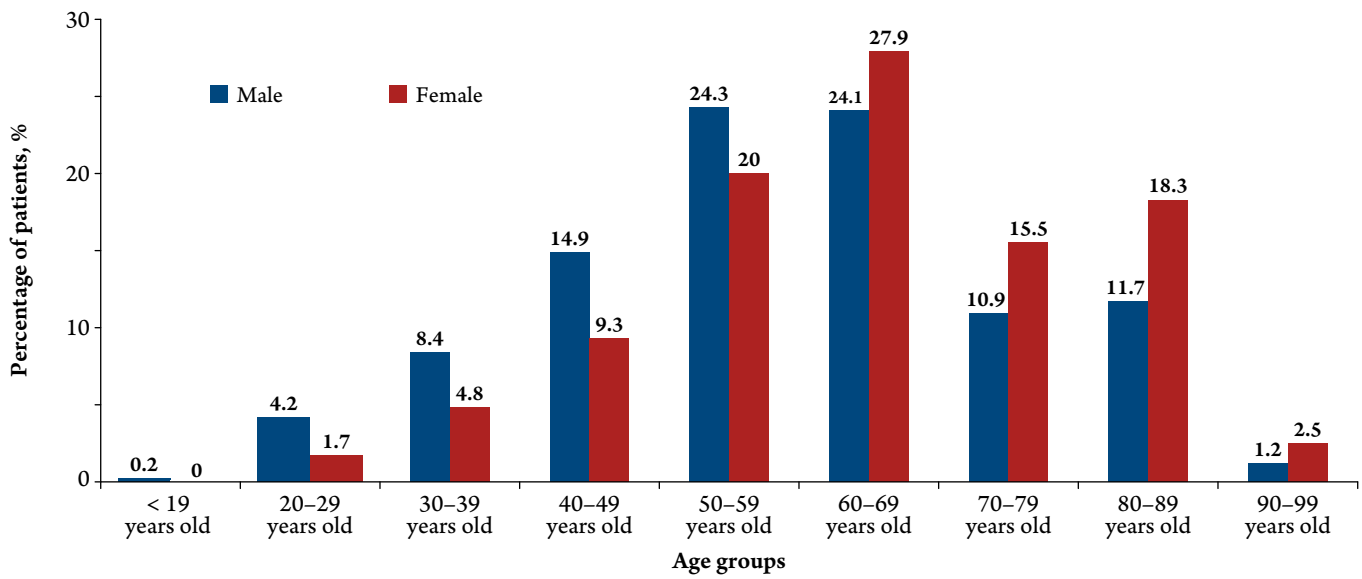


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Table 1. Characteristics of patients hospitalized with COVID-19 (n = 758)

Parameter	Number of patients	Value
Male, n (%)	758	403 (53.2)
Age, years, Me [25 %; 75 %]	758	61 [51; 72]
Age group, n (%):	758	
• < 39 years old		75 (9.9)
• 40–64 years old		388 (51.2)
• ≥ 65 years old		295 (38.9)
Social and labor status, n (%)		
• Employed	544	299 (55)
• Non-employed	544	244 (44.9)
• Student	544	1 (0.2)
• Retired	750	364 (48.5)
Current smoker, n (%)	655	68 (10.4)
BMI, kg/m², Me [25 %; 75 %]	710	28.4 [25.3; 33.1]
BMI grades, n (%):	710	
• Underweight (BMI < 18.5 kg/m²)		7 (1)
• Normal (BMI 18.5–25.0 kg/m²)		151 (21.3)
• Overweight (BMI 25.0–29.9 kg/m²)		268 (37.7)
• Obesity (BMI ≥ 30.0 kg/m²)		284 (40)
Obesity grade, n (%):	284	
• I (BMI 30–34.9 kg/m²)		164 (57.7)
• II (BMI 35–39.9 kg/m2)		88 (31)
• III (BMI ≥40 kg/m²)		32 (11.3)

BMI, body mass index.

Table 2. Incidence and structure of CVDs in patients hospitalized with COVID-19 (n = 758)

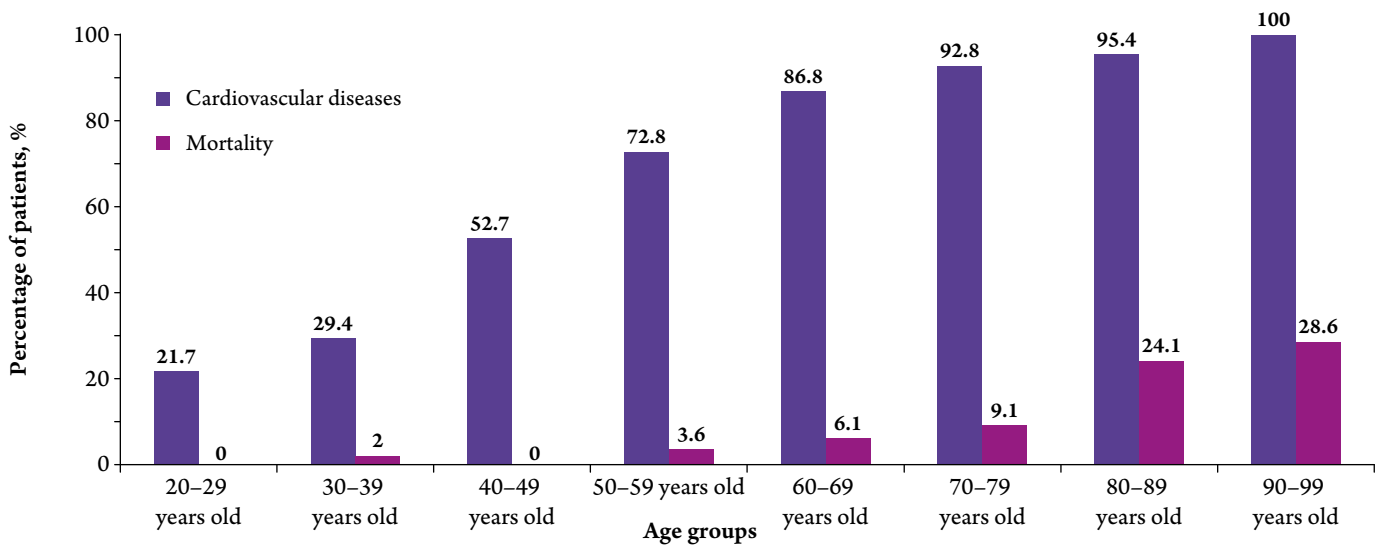
Parameter	Value, n (%)
Arterial hypertension	521 (68.7)
• Grade I	127 (24.4)
• Grade II	191 (36.6)
• Grade III	190 (36.5)
Coronary artery disease	131 (17.3)
• Angina pectoris	63 (8.3)
• History of myocardial infarction	89 (11.7)
• History of myocardial revascularization	57 (7.5)
Atrial fibrillation	136 (17.9)
• Paroxysmal AF	93 (68.4)
• Permanent AF	43 (31.6)
Chronic heart failure	86 (11.3)
CHF NYHA class	75 (9.9)
• I	10 (13.3)
• II	40 (53.3)
• III	22 (29.3)
• IV	3 (4)
Peripheral artery disease	46 (6.1)
History of cerebrovascular accident	56 (7.4)
Type of CVA	
• Ischemic stroke	49 (87.5)
• Transient ischemic attack	7 (12.5)
Diabetes mellitus	100 (13.2)
• Diabetes mellitus type 1	2 (2)
• Diabetes mellitus type 2	98 (98)

CVA, cerebrovascular accident.

patients among those hospitalized with COVID-19 being nearly 80%. Patients with grade I obesity were prevalent among obese patients.

Of the COVID-19 patients, 59 (7.8%) died while they were in the hospital, 677 (89.3%) were discharged, and 22 (2.9%) patients were moved to other hospitals because of concomitant diseases. Compared to survivors who were discharged from the hospital or transferred to other clinics, patients who died stayed in the hospital significantly shorter time: 10 [7; 15] days versus 15 [12; 19] days ($p < 0.001$).

Figure 2. Percentage of patients with CVDs and mortality depending on age of patients hospitalized with COVID-19 (n = 758)



Information on the presence or absence of the history of CVDs was available for 745 (98.3%) of the 758 hospitalized patients. 564 (75.7%) patients had a history of CVDs with AH being the most common CVD (Table 2).

Older age was associated with a higher prevalence of CVDs (p<0.001) and a higher death rate (p < 0.001; Figure 2). Univariate regression analysis (binary logistic regression) showed that with a 10-year increase in age the odds of having CVDs increase 2.2-fold (OR 2.23; 95% CI 1.93–2.58; p<0.001), and such an increase is also associated with a 92% increase in the risk of in-hospital death (HR 1.92; 95% CI 1.58–2.34; p < 0.001) according to univariate regression analysis (Cox proportional hazards model).

The number of CVDs per patient ranged from 1 to 6, the median number was 1 [1; 2], and the number of CVDs in died patients was significantly higher than in survivors (2 [1; 3] versus 1 [0; 2]; p < 0.001). Increased number of CVDs is associated with higher mortality (p<0.001; Figure 3). Univariate regression analysis (Cox proportional hazards model) showed that higher number of CVDs is associated with an increase the risk of death by 71% (HR 1.71; 95% CI 1.42–2.07; p < 0.001).

Comparative analysis showed that the mean age of died patients was higher than that of the survivors by 20 years and they did not differ by sex (Table 3). History of CVDs was more common among died patients, both in general and by particular conditions: AF, CHF, CAD, angina, history of MI, history of myocardial revascularization, CVA. Died patients were also more likely to have DM.

The Kaplan-Meier survival analysis showed that hospitalized patients with COVID-19 had a higher risk of death in the hospital if they had CVDs in general (Central figure) and in particular conditions (AF, CHF, CAD, angina pectoris, history of MI, history of CVA, DM) (Table 4).

Univariate analysis (Cox proportional hazards model) showed that the presence of any CVD increased 3.2-fold the risk of death in hospital, but when the model was adjusted for age and sex, this association was no longer significant (Table 5). The presence of separate CVDs and DM was also associated with a 1.9–5.6-fold risk of death. Only CHF was still associated with a 3 fold increase in the risk of death when the model was adjusted for age and sex. For the other CVDs and DM this relationship lost statistical significance.

Table 5 shows that, after age and sex adjustment, CHF alone of all CVDs continued to be a significant independent predictor of in-hospital death for COVID-19 patients. Based on the results of a multivariate analysis (Cox proportional hazards model), two independent predictors of in-hospital death were identified: age (HR 1.05; 95% CI 1.03–1.08;

Figure 3. Death rate in patients hospitalized with COVID-19 depending on the presence and number of CVDs (n = 745)

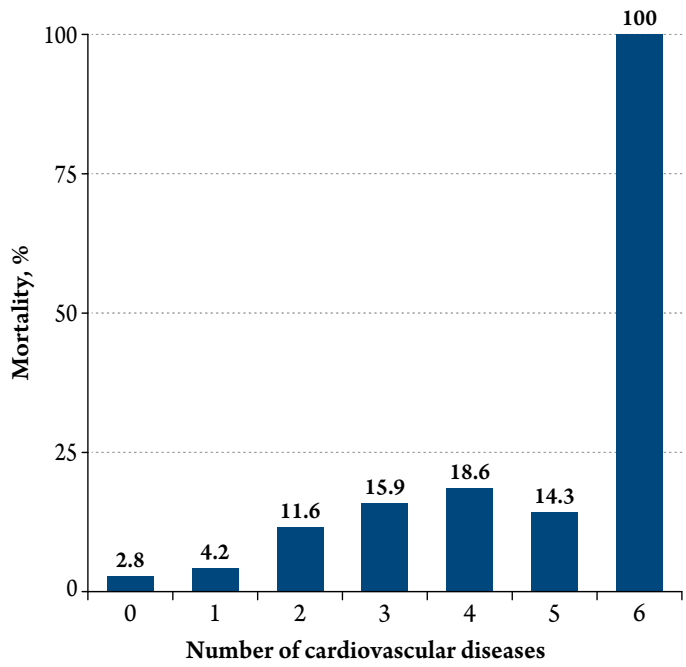


Table 3. Demographics and history of CVDs associated with in-hospital death of COVID-19 patients (n = 758)

Parameter	Number of patients	Died (n = 59)	Survivors (n = 699)	p
Age, years, Me [25 %; 75 %]	758	80 [64; 84]	60 [50; 70]	< 0.001
Male, n (%)	758	34 (57.6)	369 (52.8)	0.475
Any CVD, n (%)	745	48 (90.6)	516 (74.6)	0.009
AH, n (%)	740	40 (76.9)	481 (69.9)	0.286
AF, n (%)	748	25 (44.6)	111 (16)	< 0.001
CHF, n (%)	720	19 (42.2)	67 (9.9)	< 0.001
CAD, n (%)	747	18 (33.3)	113 (16.3)	0.002
Angina pectoris, n (%)	742	7 (14)	56 (8.1)	0.182
History of MI, n (%)	747	14 (25.5)	75 (10.8)	0.001
History of myocardial revascularization, n (%)	750	6 (10.7)	51 (7.3)	0.426
Peripheral artery disease, n (%)	721	5 (11.4)	41 (6.1)	0.191
History of cerebrovascular accident, n (%)	750	9 (16.7)	47 (6.8)	0.014
Diabetes mellitus, n (%)	750	14 (25)	86 (12.4)	0.008

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Table 4. Analysis of survival of hospitalized COVID-19 patients depending on the history of CVDs and DM (Kaplan-Meier method; n = 758)

Parameter	Number of patients	Survival rate, %		Time of survival, days*		Chi-squared test	p
		CVD (+)	CVD (–)	CVD (+)	CVD (–)		
Any CVD	745	91.5	97.2	38.6 (35.6–41.5)	42.4 (38.3–46.4)	6.7	0.010
AF	748	81.6	94.9	32.8 (29.6–36.0)	41.3 (38.8–43.7)	23.3	< 0.001
CAD	747	86.3	94.2	33.6 (30.5–36.7)	40.4 (37.9–43.0)	13.5	< 0.001
Angina pectoris	742	88.9	93.7	23.7 (21.4–26.0)	40.5 (38.2–42.8)	4.9	0.027
History of MI	747	84.3	93.8	33.1 (29.6–36.6)	40.2 (37.7–42.8)	11.2	0.001
CHF	720	77.9	95.6	30.6 (26.6–34.7)	41.6 (39.4–43.9)	41.1	< 0.001
History of CVA	750	83.9	93.5	37.3 (32.4–42.2)	39.8 (37.2–42.3)	6.0	0.014
Diabetes mellitus	750	86.0	93.5	37.1 (32.4–41.8)	40.4 (38.0–42.8)	4.1	0.044

* Data is presented as the means with 95 % confidence interval; CVA, cerebrovascular accident.

Table 5. Demographic characteristics of patients with COVID-19 and CVDs associated with fatal outcome during hospital stay (Cox proportional hazards model; n = 758)

Parameter	Number of patients	Univariate analysis			Univariate analysis with age and sex adjustments		
		HR	95% CI	p	HR	95 %CI	P
Age ≥ 80 years	758	5.56	3.32–9.34	< 0.001	5.97	3.53–10.10	< 0.001
Male	758	1.13	0.67–1.89	0.649	1.63	0.96–2.74	0.070
Any CVD	745	3.17	1.26–7.99	0.014	1.14	0.43–2.98	0.793
AF	748	3.42	2.01–5.81	< 0.001	1.60	0.92–2.79	0.096
CAD	747	2.78	1.57–4.91	< 0.001	1.45	0.81–2.62	0.214
Angina pectoris	742	2.40	1.08–5.38	0.033	1.43	0.64–3.23	0.385
History of myocardial infarction	747	2.71	1.47–4.98	0.001	1.50	0.80–2.83	0.209
CHF	720	5.58	3.08–10.09	< 0.001	2.99	1.61–5.56	0.001
History of stroke/TIA	750	2.39	1.16–4.91	0.018	1.63	0.79–3.35	0.187
Diabetes mellitus	750	1.86	1.01–3.43	0.048	1.55	0.83–2.89	0.165

Dependent variable: death HR, hazard ratio; CI, confidence interval; TIA, transient ischemic attack.

p<0.001) and CHF (HR 3.16; 95% CI 1.64–6.09; p = 0.001). The results showed that the risk of death increased by 5% with every year of age, and that the risk increased 3-fold with the presence of CHF.

The study showed that the risk of in-hospital death for patients with COVID-19 depends not only on the presence of CVDs, but also on their number and severity. The Kaplan-Meier survival analysis showed that with higher number of CVDs was associated with significantly lower patient survival (Table 6).

The Cox proportional hazards model was used to assess the impact of the severity of particular CVDs on the risk of in-hospital death. The absence of disease was considered as a reference with HR = 1.0, with which the other indicators characterizing the severity of CVDs were compared. The results showed that the risk of death progressively increases in more severe CVDs (Table 7). For example, the presence of paroxysmal and permanent AF, compared to the absence of AF, is associated with a 2.9- and 4.6-fold increase in the risk of death respectively.

It is noteworthy that the median age of died patients was 80 years, and the mortality rate in patients above 80 increased significantly (Figure 2) and was 24.6% versus 4.4% in persons younger than 80 years (p < 0.001). At the same time, according to univariate regression analysis, the age of ≥80 years was associated with a 5.6-fold increase in the risk of death (Table 5). Since CVDs are age-associated, their prevalence among patients above 80 was also naturally higher than in those younger than 80 years – 95.9% versus 71.7% (p < 0.001). In this regard, an additional analysis was performed in a subgroup of patients younger than 80 years to clarify the prognostic significance of CVDs and age as predictors of in-hospital death in COVID-19. Univariate regression analysis (binary logistic regression) confirmed that a 10-year increase in age was associated with a 2.3-fold increase in odds of having CVDs (OR 2.29; 95% CI 1.94–2.69; p < 0.001). Univariate regression analysis (Cox proportional hazards model) also showed that a 10-year increase in age is associated with an increase in the risk of death by 85% (HR 1.85; 95% CI 1.27–2.71; p < 0.001). According to the results of a multivariate analysis, age (HR 1.06; 95% CI 1.01–1.11; p = 0.017) and CHF (HR 4.34; 95% CI 1.70–11.08; p = 0.002) are independent predictors of in-hospital death in patients with COVID-19 younger than 80 years, a 1-year increase in age is associated with an increase in the risk of death by 6%, and the presence of CHF increases fold the risk of death 4.3 times. The results of the analysis in patients

Table 6. In-hospital survival of COVID-19 patients depending on the presence and number of CVDs (Kaplan-Meier survival analysis; n = 745)

Number of CVDs	Number of patients	Survival rate, %	Time of survival, days*	Chi-squared test	P
0	181	97.2	42.4 (38.3–46.4)	65.2	< 0.001
1	332	95.8	41.5 (37.6–45.4)		
2	112	88.4	37.0 (33.0–41.1)		
3	69	84.1	28.2 (25.6–30.8)		
4	43	81.4	30.9 (25.2–36.6)		
5	7	85.7	18.2 (14.9–21.4)		
6	1	0	9.0 (9.0–9.0)		

* Data is presented as the means with 95 % confidence interval.

Table 7. Influence of the severity of separate CVDs on the risk of in-hospital death in COVID-19 patients (Cox proportional hazards model; n = 758)

Parameter	Number of patients	HR	95 %CI	p
Atrial fibrillation				
No AF	612	1.00*	—	—
Paroxysmal AF	93	2.88	1.56–5.31	0.001
Permanent AF	43	4.60	2.18–9.70	< 0.001
Chronic heart failure				
No CHF	634	1.00*	—	—
NYHA class I	10	2.15	0.29–15.96	0.456
NYHA class II	40	3.72	1.53–9.06	0.004
NYHA class III	22	5.75	2.20–15.08	< 0.001
NYHA class IV	3	30.84	7.07–134.57	< 0.001
History of myocardial infarction				
No MI	658	1.00*	—	—
One MI	83	2.16	1.11–4.21	0.023
Two or more MI	6	16.92	5.15–55.65	< 0.001
Coronary artery disease				
No CAD	616	1.00*	—	—
Angina pectoris	26	3.08	0.94–10.11	0.064
History of MI	36	2.56	1.08–6.10	0.033
History of MI combined with myocardial revascularization	25	3.10	1.10–8.71	0.032
History of angina combined with MI	12	6.16	1.88–20.14	0.003

* Reference category. Dependent variable: death HR, hazard ratio; CI, confidence interval.

with COVID-19 younger than 80 years are generally consistent with the data obtained for the general sample.

Discussion

Our study added to the rapidly growing body of evidence about predictors of death in COVID-19 and showing associations between CVDs and mortality according to the hospital registry. According to the results of the univariate regression analysis, both CVDs in general and separate conditions (CAD, AF, CHF, CVA, peripheral arterial disease) are associated with in-hospital mortality, however, only age and CHF were independent predictors of in-death hospital in COVID-19 according to the multivariate regression analysis.

It is undoubtedly of interest to compare our findings with data from other studies, such as large international registry ACTIVE (7 countries, 5,808 hospitalized patients and 1,057 ambulatory patients with COVID-19) [8]. Despite a slightly younger median age (median 59 [50; 69] years), the baseline characteristics of hospitalized subjects were comparable to those of our patients, and the in-hospital mortality was the same (7.6%), but the median age of died patients (70 years) was lower by 10 years than in our study. The ACTIVE registry showed a negative effect of obesity, DM, kidney disorders, lung diseases, malignancies, CVDs, particularly AH, on the prognosis, each separate CVD was associated with a 3–5-fold increase in the risk of death, and polymorbidity increased this risk even more: a cluster of 4 diseases (AH, CAD, CHF, DM) was associated with OR 4.22 (95% CI 2.78–6.38). It should be noted that, unlike in our study, multivariate regression analysis was not used in this registry. In this regard, it remains unclear whether the predictors of death found are independent.

The results of international studies on the problem under consideration are summarized in several meta-analyses. One of the first meta-analyses [9] included 49 studies and almost 600 thousand cases, which, as in our study, were registered during the first wave of the COVID-19 pandemic. The risk of death during hospitalization was shown to be increased by advanced age, male sex, concomitant CVDs (OR 1.95; 95% CI 1.08–3.54), acute heart or kidney damage, lymphocytopenia, and elevated D-dimer levels. Another meta-analysis was conducted soon after to examine the role of CVDs in COVID-19 [10]. It included 56 studies (160 thousand patients) published before June 2020. The authors identified statistically significant associations with fatal outcomes of acute myocardial injury (OR 13.29; 95% CI 7.35–24.03), AH (OR 2.60; 95% CI 2.11–3.19), CHF (OR 6.72; 95% CI 3.34–13.52), CAD (OR 3.78; 95% CI 2.42–

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5.90), arrhythmias (OR 2.75; 95% CI 1.43–5.25), and CVDs in general (OR 2.61; 95% CI 1.89–3.62).

Some of the early meta-analyses had methodological limitations, for example, they included multiple studies performed in the same hospital and close in time. In this regard, a meta-analysis of 20 studies (15,408 cases of COVID-19) [11], the design of which was aimed at overcoming these limitations, is of interest. It was found that advanced age, male sex, smoking, and some diseases – DM, CVDs, particularly AH, respiratory diseases, and chronic kidney disease – are significantly associated with the rate of in-hospital deaths.

The results of our study regarding the negative impact of CVDs on the prognosis of COVID-19 are consistent with international experience gained nearly at the same time. It should be noted that, after being adjusted for age, most of the established associations lost statistical significance. A meta-analysis focusing on the possible influence of age as a factor affecting the relationship between CVDs and poor prognosis in COVID-19 and summarized data from 51 observational studies, which included 48,317 hospitalized patients distributed by age (ranges: < 50 years, 50–60 years, and ≥ 60 years) [12]. In general, the relative risk of severe COVID-19 or death was significantly higher in patients with cardiovascular risk factors (AH – OR 2.50; 95% CI 2.15–2.90; DM – OR 2.25, 95% CI 1.89–2.69) and in the presence of CVDs (OR 3.11; 95% CI 2.55–3.79). In contrast to our study, in this meta-analysis, the relative risk of death was higher in younger patients (< 50 years) in the subgroups of patients with CVDs or risk factors (RFs) compared with older age categories, although the hazard ratios had a relatively broad 95% CI. The authors explained this finding by the likelihood of worse RF control and late request for medical care by younger people who underestimated the severity of the infection.

Similar results were obtained in a cohort study including more than 1,700 patients with severe COVID-19 (mean age 71 years, 57% of males) admitted to two British hospitals from March to June 2020. CVDs were independently associated with death in patients under 70 years of age (HR 2.43; 95% CI 1.16–5.07) compared to patients above 70 (HR 1.14; 95% CI 0.77–1.69). In contrast, cardiovascular RFs, particularly AH, were not associated with death outcomes in either age groups (< 70 years: HR 1.21; 95% CI 0.72–2.01; ≥ 70 years: HR 1.07; 95% CI 0.76–1.52) [13], which is consistent with our data. Authors of another meta-analysis [14] tried to clarify the prognostic significance of individual cardiovascular RFs of CVDs. In this meta-analysis of 45 studies including 18,300 patients (in-hospital mortality was 12%), univariate analysis showed a significant association of mortality with age, DM, and AH, while male sex and smoking did not affect mortality. In age-adjusted multivariate regression analysis, there was still statistically significant association with DM, but not AH.

Thus, the cardiovascular RFs, with the exception of age, demonstrate different prognostic significance for the severe course and death in COVID-19 (up to their absence). On the contrary, the totality of information suggests that confirmed CVDs increase the risk of death.

Conclusion

Given the above, our findings show that CVDs and the corresponding RFs are associated with poor prognosis for COVID-19, with more severe CVDs showing stronger associations. As mentioned earlier, patients with CHF can be considered as the group with the most severe comorbidity. CHF is essentially an integral indicator reflecting the state of the cardiovascular system. The relationship between CHF and COVID-19 may be due to the aggravation of pre-existing CHF in systemic infection and/or the myocardial damage or myocarditis associated with the infectious disease [15].

In our opinion, the study is limited by smaller sample size compared with studies conducted particularly by Chinese and American colleagues, and the international research groups. At the same time, our study is distinguished by a large number of analyzed parameters, inclusion of all patients in the register from the moment of hospitalization, the enrollment of patients in one site, and thus similar approaches to patient management used in the hospital. The data presented in the article are the result of the therapeutic strategy used at that time and adopted during the period of the most aggressive course of COVID-19 and the lack of preventive vaccination.

Anyway, the available extensive evidence is a good basis for special attention to COVID-19 patients with concomitant CVDs, especially CHF. They face a very high risk of adverse outcomes and require timely vaccination to prevent COVID-19, and if an infectious disease develops – the entire complex of therapeutic and rehabilitation measures should be taken, including the administration of modern cardioprotective drug therapy and rehabilitation programs to prevent complications.

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