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# Outcomes of patients with implanted cardioverter-defibrillators admitted to the Emergency Department due to electrical shock during the pre-pandemic and COVID-19 pandemic era

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**Outcomes of patients with implanted cardioverter-defibrillators admitted to the Emergency Department due to electrical shock during the pre-pandemic and COVID-19 pandemic era**

**Short title:** ICD and CRT-D patients in the Emergency Department: Pre & COVID-19 era

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**WHAT'S NEW?**

The global COVID-19 pandemic has profoundly affected healthcare systems, necessitating significant changes in patient care worldwide. Particularly vulnerable are patients with implantable cardioverter-defibrillators or cardiac resynchronization therapy with defibrillation, who require meticulous monitoring and specialized attention. This study investigated the impact of the pandemic on hospitalizations in this patient cohort and revealed that despite the pandemic, hospitalization rates remained unaffected. However, patients with concurrent SARS-CoV-2 infection experienced elevated in-hospital shock incidents and an increased mortality rate. These findings enhance our comprehension of the pandemic's influence on specific patient populations and offer valuable insights for future healthcare planning and resource allocation during comparable crises.


## ABSTRACT

**Background:** Implantable cardioverter-defibrillators (ICD)/cardiac resynchronization therapy with defibrillation (CRT-D) recipients may be susceptible to the arrhythmic effects of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection.

**Aims:** Evaluation of the characteristics and outcomes of patients hospitalized due to ICD/CRT-D shocks during the pandemic compared to the pre-pandemic period.

**Methods:** This retrospective study analyzed medical records of patients hospitalized due to ICD/CRT-D shock in the pre-pandemic period (January 1, 2018–December 31, 2019) and pandemic period (March 4, 2020–March 3, 2022). Survival data were obtained on October 24, 2022.

**Results:** In total, 198 patients (average age 65.6 years) had 138 pre-pandemic and 124 pandemic visits. Of these 198, 115 were hospitalized during pre-pandemic, 108 during the pandemic, and 25 in both periods. No significant differences were noted in age, sex, shock number, or therapy appropriateness between periods. At pandemic, during 14 hospitalizations of patients with SARS-CoV-2; 8 (57.1%) received electrical shocks, compared to 12 (10.9%) with negative SARS-CoV-2 ($P$ <0.001). The in-hospital mortality was 2 out of 115 patients hospitalized during pre-pandemic and 7 out of 108 during pandemic; 4 with and 3 without SARS-CoV-2 ($P$ = 0.10). During the follow-up there were 66 deaths. Cox regression analysis showed survival decreasing with age and heart failure decompensation in medical history but increasing with higher ejection fraction. Pandemic alone wasn't a survival predictor. However, SARS-CoV-2 infection, older age, and heart failure decompensation in medical history predicted worse outcomes during the pandemic period.

**Conclusions:** The coronavirus disease 19 pandemic did not increase hospital visits due to ICD/CRT-D discharges. SARS-CoV-2 infection predicts increased mortality in patients with ICD/CRT-D shocks.



**Key words:** cardiac resynchronization therapy, COVID-19, hospitalization, implantable cardioverter defibrillator, pandemic


## INTRODUCTION

Coronavirus disease 19 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first cases were recognized in December 2019 in

Wuhan, China [1]. In Poland, the first case of COVID-19 disease was documented on March 4, 2020 [2]. Since then, the number of infected patients has increased rapidly [3, 4]. The symptoms of respiratory damage predominate, but signs of cardiovascular involvement are frequent [5, 7]. Direct cardiac injury, autonomic dysfunction, stress myocardiopathy, vascular thrombosis, electrolyte disturbances, and release of proinflammatory cytokines are often encountered in patients with SARS-CoV-2 infection. Increased metabolic demand, combined with the abovementioned factors, could evoke cardiac arrhythmias, being usual extrapulmonary manifestations of the disease [7]. Patients with chronic conditions are particularly vulnerable to severe disease courses and increased risk of death [8, 9]. Many of these patients have an implanted cardioverter-defibrillator (ICD) or a cardiac resynchronization therapy defibrillator (CRT-D), and COVID-19 have caused appropriate shocks triggered by ventricular arrhythmias and inappropriate shocks triggered by atrial fibrillation (AF) with a rapid ventricular response [10–12]. Furthermore, sinus tachycardia, often encountered in COVID-19, could be responsible for the inappropriate shock triggering [13]. However, the lower percentage of lethal ventricular arrhythmias in the general population during the pandemic era compared to the pre-pandemic period was indicated by the decrease in the percentage of shockable first recorded rhythm in patients with cardiac arrest [7]. The results of analyses on ICD shocks during the pandemic are contrasting [14, 15]. The electrical shock occurrence in ICD/CRT-D recipients could be increased by overall psychological stress [16, 17]. In contrast with these assumptions, lockdown and decreased physical activity reduce the occurrence of shocks [10–12].

This retrospective study aimed to evaluate Emergency Department (ED) admissions related to high-energy therapy, examining patients' clinical characteristics and outcomes during both the pre-pandemic and COVID-19 pandemic periods. Secondary aims included assessing the incidence of SARS-CoV-2 infections among these patients and comparing the clinical data and outcomes between those with and without SARS-CoV-2 infection. The findings contribute valuable insights into the impact of the COVID-19 pandemic on high-energy therapy cases, highlighting potential implications for patient management during infectious outbreaks.

## METHODS

The study was designated as a retrospective analysis of the medical records of patients with ICD/CRT-D admitted to 2 high-volume hospitals due to high-voltage therapy. Admission to the ED was considered as admission to the hospital. A total of 36 patients (13.1%) were discharged home from the ED.

At the beginning of the COVID-19 pandemic, patients were mainly admitted to Infectious Disease Hospitals [3, 4]. By the beginning in September 2020, most patients requiring hospitalization were admitted to the nearest hospitals [18]. Only those patients requiring tertiary care procedures were referred to designated hospitals.

All admissions of these patients to the EDs during two 24-month periods were evaluated: 138 admissions in the pre-pandemic era January 1, 2018–December 31, 2019 and 124 visits during pandemic period: March 4, 2020–March 3, 2022).

Age, gender, therapy appropriateness, number of shocks, symptoms before shock that are presumed to provoke factors, comorbidities, the cause of ICD/CRT-D implantation, and SARS-CoV-2 swab test results in the pandemic era were gathered from electronic recordings. The time of the ICD interventions was assessed as before hospital admission or before and during hospitalization. The presence of dyspnea, fatigue, chest pain, vomiting, fever, or hemorrhage before the electrical shock was defined as the presence of symptoms not related to arrhythmia or ICD/CRT-D high-voltage therapy unless otherwise proven. Loss of consciousness during electrical shock was considered arrhythmia related. The presence of electrical shocks during hospitalization was assessed based on the medical recordings. Furthermore, the procedures: ventricular ablation, supraventricular arrhythmia ablation: (pulmonary vein isolation, tricuspid isthmus ablation, ablation of the atrio-ventricular junction, ablation of the slow pathway of the atrioventricular node), coronary artery catheterization, coronary angioplasty, amiodarone or lidocaine administration during hospitalization were noted. The medical records of the patients were looked for general anesthesia of the patients aiming to treat electrical shocks.

In case of the patients who died in hospital the first recorded rhythm during the last cardiac arrest was noted.

The therapy of COVID-19 was conducted as recommended by Polish experts [19, 20].

The ED at the University Hospital and the ED at the 4$^{th}$ Military Hospital are 2 of 4 EDs in Wroclaw, a principal city of the Lower Silesia voivodeship with approximately 800 000 inhabitants.

During the third and fourth wave of the pandemic period, the 4$^{th}$ Military Hospital was designated as the regional center for the treatment of patients with SARS-CoV-2 infection who needed treatment with pacemaker implantation, ablation, coronary angiography, angioplasty, or cardiac surgery.

The main outcome was all-cause mortality. Survival until hospital discharge was assessed based on the hospital records, and medium-term survival was assessed on the basis of the data obtained from the Ministry of Digitalization on October 24,2022. The patients lost to follow-up were assessed as alive at the last contact (censored data).

## Statistical analysis

Statistical analyses were carried out with standard statistical software (Statistica version 13, TIBCO Software Inc., Palo Alto, CA, US).

Continuous variables were presented as mean and standard deviation for normally distributed data and as the median and interquartile range (IQR) for non-normally distributed data. Student's T-test and the Mann–Whitney U test were used for the statistical analysis of the differences, respectively. Categorical variables were presented as numbers and percentages and compared with the chi-squared test with Yates correction if necessary.

Survival after the hospital visit was assessed as survival until hospital discharge, and one-month and 6-month survival. For these analyses, all visits were taken into account.

For medium-term survival analysis, only the patient's last visit was considered. A Cox regression model was used to perform univariable and multivariable analyses. The covariates of the multivariable regressions were selected based on univariable regression results. Two models were built. The stepwise multivariable regression result was presented. The first model included demographics, past medical history data that were significant in the univariable analysis, the pandemic period, and used invasive procedures during hospitalization. The second model included demographics, shock number, and symptoms before shock(s).

Furthermore, the third model was built to assess the survival in patients in whom the last visit was during the pandemic period. The model included all the variables relevant in the first model and the presence of SAR-CoV-2 infection

*P* less than 0.05 was considered as significant.

# RESULTS

## Demographics

The study group consisted of 198 patients (36 women, 162 men) aged 65.6 (standard deviation 12.8 years), range 20–90 years.

## Hospital visits during pre-pandemic and pandemic period

During the study period, 149 patients had one visit due to electrical shock, 36 had 2 visits, 11 had 3 visits, and 2 had 4 visits. A group of 25 patients were admitted to the EDs during the pre-pandemic and pandemic era, and 173 patients were admitted only during the pandemic or pre-pandemic era. The first visit of 115 patients was in the pre-pandemic era, and 83 patients' first visit was during the pandemic era. The last admission to the hospital during the study period was during the pre-pandemic era in 90 (45.5%) cases, whereas it was during the pandemic era in 108 (54.5 %) cases. A total of 115 patients had at least one admission to the hospital during the pre-pandemic, and 108 patients had at least one admission during the pandemic era.

A total of 262 admissions were found during the study period: 138 (52.7%) admissions during the pre-pandemic and 124 (47.3%) during the pandemic era. The 14 visits involving patients with a positive test for SARS-CoV-2 infection occurred in 14 different patients: in 12 cases as the only visit, in one case as the first visit but not the last visit, and in one case as neither the first nor the last visit during the study period.

The number of admissions during the pre-pandemic period and pandemic period in the 4$^{th}$ Military Hospital was 89 and 91, respectively, whereas the number of admissions to the University Hospital was 49 and 33, respectively ($P$ = 0.21).

**Clinical characteristics**

A comparison of clinical characteristics of the patients' visits during the pre-pandemic and pandemic era is presented in Table 1. There were no significant differences in age, gender, shock count, appropriateness of the therapy, and hospital survival.

In the Table 2 the comparison of clinical characteristics of 90 patients' whose the last visit was during the pre-pandemic and an 108 patients whose the last visit wad during pandemic era was presented.

There were no significant differences between analyzed parameters.

Table 3 presents a comparison of clinical characteristics of the patients' visits during the pandemic era with and without SARS-CoV-2 infection. The patients with SARS-CoV-2 infection more often had hospital shocks and higher hospital mortality. Furthermore, the patients with SARS-CoV-2 infection more often had complaints before electrical discharge than did the patients without that infection. Dyspnea was reported in patients with SARS-CoV-2 infection nearly 3 times more frequently than in patients without SARS-CoV-2 infection. Among 14 patients with SARS-CoV-2 infection, the admission was *via* Emergency Medical Services (EMS) in 3 cases, transfer from an outpatient clinic in 3 cases, transfer from another hospital department in 5 cases, and of their own accord in 3 cases.

The comparison of patients with and without COVID-19 during the pandemic era was presented in the Table 4. The patients admitted with COVID-19 disease had more often symptoms not related to ICD/CRT-D discharge and higher level of C-reactive protein.

During the pre-pandemic era 115 patients were admitted at least once, and 2 of them died. During the pandemic era, at least once 108 patients were admitted, and 7 of them died ($P$ = 0.10).

**Implanted devices**

The distribution of the implanted devices in the pre-pandemic and pandemic periods was presented in the Tables 1 and 2. There were 6 admissions in 5 patients with implanted subcutaneous ICD (S-ICD) — one admission during the pre-pandemic period and 5 admissions during the pandemic period. Three admissions were related to the inadequate electrical shock. All the patients with implanted S-ICD admitted during pandemic period had negative SARS-CoV-2 tests.

**Follow-up**

All but 2 patients who were lost for follow-up were followed until October 24, 2022. The survival for these patients was assessed as one day, and their survival data were considered censored.

The median time of follow-up from the first visit to the hospital due to electrical shock during the study period was 712 (IQR, 360–1125) days.

The median time of follow-up from the last visit to the hospital due to electrical shock was 558 (IQR, 309–982) days.

**In hospital mortality**

The total in hospital mortality was 9, 2 patients died during the pre-pandemic period and 7 during the pandemic period. Among patients who died in hospital during pandemic period 4 had COVID-19 disease.

None of the patients who died had incessant ventricular arrhythmia. The deaths were due to multiorgan failure in 7 cases and the first recorded rhythm during their last cardiac arrest were asystole in 3 cases, pulseless electrical activity in 3 causes and VF in one patient in whom after defibrillation asystole occurred and there was no return of any electrical activity. One patient who was brought by EMS during ongoing resuscitation had asystole at admission. The analysis of the memory of his ICD revealed that the electrical shocks were triggered probably by chest compressions and the cardiac arrest was not caused by ventricular arrhythmia.

**Medium term mortality**

During the 30 days after the last visit, 8 patients died: one in the pre-pandemic era and 7 in the pandemic era. It constituted 0.7% of the patients who had at least one visit during the pre-pandemic era and 6.5% of the patients with at least one visit in the pandemic era (*P* = 0.059).

During the 6-month follow-up, 29 (15%) patients died: 13 (15%) with the last visit during the pre-pandemic era and 16 (15%) with the last visit during the pandemic era (*P* = 0.92)

During the follow-up, 42 (47%) patients died whose last visit was during the pre-pandemic era and 24 (22%) patients whose last visit was during the pandemic era. However, the follow-up duration of the non-survivors during the pandemic era was significantly lower than during the pre-pandemic era (126.5 [IQR, 21–202.5] vs. 446 [IQR, 144-721]; *P* <0.001).

In the Table 5 the univariable Cox regression analysis was presented.

The multivariable proportional hazards Cox regression analysis of the first model presented in the Table 6 revealed that the medium-term survival depends on the patient’s age, heart failure (HF) decompensation in the medical history, ejection fraction, but not on the period (pandemic vs. pre-pandemic) of the study.

The analysis of the second model which included demographics, shocks number before admission, period of the study (pandemic vs. pre-pandemic) and symptoms before the shocks revealed that the survival was decreased when the electrical shocks were preceded by dispone (HR, 3.428; 95% CI, 2.090–5624; *P* <0.001) or diarrhea (HR, 9.719; 95% CI, 4.075–23.176; *P* <0.001)

The analysis of the medium term survival only of the patients whose last visit was during the pandemic period revealed that the survival in this subgroup was related to the patients age, HF decompensation in the medical history and the presence of Sar-CoV-2 infection (Table 7).

## DISCUSSION

Cardiac arrhythmias have been found in 10%–20% of hospitalized COVID-19 patients [21]. The cardiac involvement and/or the effects of fever, inflammation, and hypoxia caused by any critical illness may account for this association [22]. Also, patients’ underlying susceptibility to arrhythmia may modulate its occurrence. The most common arrhythmia found during COVID-19 was AF, whereas ventricular tachyarrhythmias were reported less frequently [7]. AF with rapid ventricular response and ventricular tachyarrhythmia in patients with ICD/CRT-D may lead to shock delivery, prompting patients to attend the ED.

The study’s first finding is that the number of admissions to the ED due to ICD/CRT-D electrical shocks has not increased during the pandemic. The finding is in contrast with the results of the retrospective analysis of Adabag et al. [14], who reported an increase in the number of device high-energy interventions. Contrary to Adabag et al., O'Shea et al. [15] reported fewer electrical shocks during the pandemic. Furthermore, other authors found no significant difference between pre-pandemic and pandemic periods regarding the occurrence of ICD therapies [23]. Of note, in the present study, we investigate the number of ED admissions, not the total number of patients experiencing electrical shocks. Therefore, the reason for the slightly decreased number of ED admissions may not reflect changes in the total number of electrical shocks in the population. The patients' reluctance to attend the ED may decrease the number of admissions [24].

Furthermore, the number of electrical shocks unrelated to ventricular arrhythmia increased during the last phase of life [25]. During the pandemic, transportation to the tertiary care center for patients with multiorgan failure is considered unnecessary. The population of patients with an implanted ICD/CRT-D often have pre-existing HF [26]. The mortality rate during the pandemic of patients with pre-existing heart disease is increased [27]. Therefore, it can be presumed that the size of the susceptible population may decrease with each pandemic wave. Finally, the timing should be taken into account. In a report by Tajstra et al. [28], in Poland, during the early pandemic phase, the number of high-energy interventions did not change compared to the reference period, which may be related to the low number of infected patients. Contrary to this report, Ducceschi et al. [29] reported that in Italy, the second-most affected country in the world after China, at the beginning of the pandemic, the percentage of patients with ventricular tachycardia/ventricular fibrillation doubled.

The second finding was that the percentage of patients with SARS-CoV-2 infection among patients with ICD/CRT-D shocks was about 10%. The percentage of patients with SARS-CoV-2 infection was higher than in the general population of ED patients in the same region, which during the third wave was reported to be 6.5% [30]. This finding aligns with the assumption that the occurrence of shocks increases during the infection.

The third finding was that patients with SARS-CoV-2 infection admitted to the ED due to electrical shock have higher in-hospital and medium-term mortality than those without the infection. This finding is concordant with the reports of other authors who found that patients with acute cardiovascular disorders and concomitant SARS-CoV-2 infection have a worse prognosis than those without SARS-CoV-2 infection [31–33].

Comparing the clinical presentation of patients with and without COVID-19, it was found that patients with SARS-CoV-2 infection rarely had a ICD/CRT-D electrical shock that was not preceded by symptoms of infection. Moreover, the patients with a SARS-CoV-2-positive test had higher C-reactive protein concentrations. Furthermore, the hospital observations indicated a higher number of ICD/CRT-D discharges in patients with SARS-CoV-2 infection than in those with a negative test. These findings indicate that the predisposing factor in patients with COVID-19 is related to the infection and persists after admission, resulting in further ICD/CRT-D shocks. These findings concur with the assumption of Adabag et al. [14] that the missing links between the substrate of HF and ICD/CRT-D discharges are in the transient factors, like viral infections, which can exacerbate the patient's condition and trigger an arrhythmia.

Furthermore, the assessment of the timing of the electrical shocks in patients with SARS-CoV-2 indicates that the electrical shocks are triggered after the onset of the infection symptoms. This finding aligns with the case report of Mitacchione et al. [34] presenting the timeline of SARS-CoV-2 infection, ventricular arrhythmia, and electrical shocks. These authors found that the ventricular arrhythmia occurred at the onset of the infection, 20 days before hospital admission, but the electrical storm occurred on the 8$^{th}$ day of hospitalization [34]. Hypoxia-induced intracellular calcium overload leading to early afterdepolarization was considered to be the mechanism of ventricular arrhythmia [34]. Also, Kasinadhuni et al. [35] reported an electrical storm event in a patient on the 5$^{th}$ day of SARS-CoV-2 infection. The electrolyte concentration was within normal limits in the patient. Electrolyte disturbances seem to be less critical in ventricular arrhythmia occurrence in patients with SARS-CoV-2 infection. In the present study, dyselectrolytemia was found in a similar percentage of patients with and without the infection. It is possible that SARS-CoV-2 infection triggers ventricular arrhythmias via cytokines like interleukin-6, interleukin-1, or tumor necrosis factor-α, which can modulate $K^+$ and/or $Ca^{2+}$ channels and prolong the action potential duration [36].

The frequency of the cardiologic procedures like catheter ablation, coronary catheterization and angioplasty did not differ between pre-pandemic and pandemic period. During pandemic period the temporary deferment of non-urgent elective electrophysiological procedures was recommended [37]. However, the invasive procedures in patients with electrical shocks during COVID-19 pandemia were considered as life saving therefore were performed.

The mortality rate was increased during pandemic in the whole world [37]. In 2020 in Poland the excess of death was about 15% whereas for example in Austria it was 7.6% [38]. The difference could be the consequence of the higher burden of disease in Polish society than the average for the European Union countries. The other factor related to excess mortality could be the difficult access to doctors during the pandemic and an ineffective pro-vaccination campaign. However the presented data indicate that the increased in-hospital death in patients admitted due to electrical shocks was related only to SARS-CoV-2 infection.

An additional finding of the study is that the number of patients with S-ICD was higher in the pandemic period in comparison to the pre-pandemic one, what is concordant with data presented in the Kempa et al. [39] paper showing increasing number of S-ICD implantations in Poland.

## Limitations

The main limitation of the study is its retrospective character. Furthermore, on the basis of the recorded data, multiple shocks could not be distinguished due to one episode from multiple shocks of recurrent ventricular tachyarrhythmias fulfilling the electrical storm criteria. During the pandemic era, in ED it was not possible to record all data.

The impact of lockdown on easy access to drugs prescription and cardiovascular drugs compliance and patients' decision to call ambulance or transfer to the ED cannot be validated. The other limitation is that the prevalence of the electrical shocks may be underestimated due to lack of the remote control and monitoring of implantable electronic devices.

Moreover, the studied groups were relatively small. Because of small group of patients with COVID-19 the impact of COVID-19 therapy was not analyzed in this study.

## CONCLUSIONS

The admissions to the ED during the SARS-CoV-2 pandemic due to ICD/CRT-D shocks remained on the same level as before.

During the 2 years of the COVID-19 pandemic, among patients with ICD/CRT-D discharges treated in hospital, about 10% of patients had a positive SARS-CoV-2 smear test.

The patients with SARS-CoV-2 infection more frequently had symptoms unrelated to arrhythmia or ICD/CRT-D discharge before admission, electrical discharges from ICD/CRT-D during hospitalization, and higher mortality than non-COVID patients.

Patients with SARS-CoV-2 infection had higher C-reactive protein concentration but did not differ in other studied laboratory parameters from those without the infection.

## Article information

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**Table 1.** Comparison of the details of patients' visits during the pre-pandemic and pandemic era

| | Pre-pandemic era<br>n = 138 | Pandemic era<br>n = 124 | *P*-value |
|---|---|---|---|
| Age, years, median (IQR) | 68 (61–74) | 67 (61–73) | 0.304 |
| Male, n (%) | 114 (82.6) | 102 (82.3) | 0.94 |
| Secondary prevention, n (%) | 49 (33.5) | 46 (37.1) | 0.62 |
| CRT-D<br>ICD<br>S-ICD | 32 (23)<br>105 (76)<br>1 (1) | 29 (23)<br>90 (1)<br>5 (4) | 0.18 |
| Number of shocks before admission, median (IQR) | 2.5 (1–6) | 2 (1–6) | 0.764 |
| Appropriate, n (%) | 98 (71.0) | 91 (73.4) | 0.67 |
| Non-appropriate, n (%) | 34 (24.6) | 30 (24.2) | 0.93 |
| Appropriate and non-appropriate, n (%) | 6 (4.4) | 3 (2.4) | 0.39 |
| IHD, n (%) | 97 (70) | 80 (65) | 0.13 |
| HCM, n (%) | 2 (1) | 9 (7) | |
| DCM, n (%) | 36 (26) | 32 (26) | |
| Others, n (%) | 3 (2) | 3 (2) | |
| ICD/CRT-D discharges during hospitalization | 16 (12) | 20 (16) | 0.29 |
| Arrival by EMS, n (%) | 88 (64) | 61 (49) | 0.12 |

| | | | |
|---|---|---|---|
| Chest pain before the shock, n (%) | | | |
| Ventricular ablation, n (%) | 25 (18.1) | 14 (11.3) | 0.12 |
| Supraventricular arrhytmia ablation, n (%) | 3 (2.2) | 3 (2.4) | 0.92 |
| Coronary angiography, n (%) | 57 (41.3) | 41 (33.1) | 0.17 |
| Coronary angioplasty, n (%) | 16 (11.6) | 12 (9.7) | 0.62 |
| Amiodarone, n (%) | 42 (30.4) | 39 (31.5) | 0.86 |
| Lidocaine, n (%) | 3 (2.2) | 8 (6.5) | 0.16 |
| External cardioversion, n (%) | 2 (1.5) | 3 (1.4) | 0.90 |
| In hospital mortality, n (%) | 2 (1.4) | 7 (5.5) | 0.13 |
| 6-month mortality | 13 (9) | 17 (14) | 0.28 |

Abbreviations: CRT-D, cardiac resynchronization therapy defibrillator; DCM, dilated cardiomyopathy; EMS, Emergency Medical Services; HCM, hypertrophic cardiomyopathy; ICD, implantable cardioverter defibrillator; IHD, ischemic cardiomyopathy; IQR, interquartile range; S-ICD, subcutaneous ICD

**Table 2.** Comparison of 90 patients whose last visit took place in the pre-pandemic period and 108 whose last visit took place during the pandemic period (only the parameters related to the last visit of the given patient were analyzed)

| | Pre-pandemic era n = 90 | Pandemic era n = 108 | *P*-value |
|---|---|---|---|
| Age, years, median (IQR) | 68 (61–73) | 67 (61–73) | 0.57 |
| Male, n (%) | 74 (82) | 88 (81) | 0.89 |
| Secondary prevention, n (%) | 35 (39) | 40 (37) | 0.52 |

| | | | |
|---|---|---|---|
| CRT-D<br>ICD<br>S-ICD | 69 (77)<br>20 (22)<br>1 (1) | 76 (70)<br>28 (26)<br>4 (4) | 0.40 |
| Number of shocks before admission, median (IQR) | 2.5 (1–6) | 2.5 (1–7) | 0.45 |
| Appropriate, n (%) | 62 (69) | 78 (72) | 0.37 |
| Non-appropriate, n (%) | 23 (26) | 28 (26) | |
| Appropriate and non-appropriate, n (%) | 5 (6) | 2 (2) | |
| IHD, n (%) | 59 (66) | 70 (65) | 0.69 |
| HCM, n (%) | 2 (2) | 6 (6) | |
| DCM, n (%) | 26 (29) | 29 (27) | |
| Others, n (%) | 3 (3) | 3 (3) | |
| ICD/CRT-D discharges during hospitalization | 8 (9) | 16 (15) | 0.20 |
| Arrival by EMS, n (%) | 57 (63) | 55 (51) | 0.23 |
| Ventricular ablation, n (%) | 14 (16) | 13 (12) | |
| Supraventricular arrhythmia ablation, n (%) | 2 (2) | 1 (1) | 0.87 |
| Coronary angiography, n (%) | 35 (39) | 34 (31) | 0.28 |
| Coronary angioplasty, n (%) | 10 (11) | 9 (8) | 0.51 |
| Amiodarone, n (%) | 26 (29) | 34 (31) | 0.69 |
| Lidocaine, n (%) | 1 (1) | 7 (6) | 0.12 |
| External cardioversion, n (%) | 0 (0) | 2 (2) | 0.60 |
| In hospital mortality, n (%) | 2 (2) | 7 (7) | 0.27 |
| 6-month mortality | 13 (15) | 16 (15) | 0.89 |

Abbrevations: see Table 1

**Table 3.** Comparison of the details of patients' visits with and without coronavirus disease 2019 (COVID-19)

| | Non-COVID-19 n = 110 | COVID-19 n = 14 | *P*-value |
|---|---|---|---|
| Age, years, median (IQR) | 67 (61–73) | 67 (58–67) | 0.82 |
| Gender, male, n (%) | 89 (80.9) | 13 (92.9) | 0.46 |
| Number of shocks before admission, median (IQR) | 2 (1–7) | 2 (1–4) | 0.53 |
| Shocks<br>— appropriate, n (%)<br>— non-appropriate, n (%)<br>— both, n (%) | <br>81 (73.6)<br>26 (23.6)<br>3 (2.7) | <br>10 (71.4)<br>4 (28.6)<br>0 (0) | <br>0.86 |
| ICD/CRT-D discharges during hospitalization, n (%) | 12 (10.9) | 8 (57.1) | <0.001 |
| Arrival by EMS, n (%) | 58 (52.7) | 3 (21.4) | 0.06 |
| In-hospital mortality, n (%) | 3 (2.7) | 4 (28.6) | <0.001 |
| Ventricular ablation, n (%) | 13 (11.8) | 1 (7.1) | 0.94 |
| Supraventricular ablation, n (%) | 2 (1.8) | 1 (7.1) | 0.77 |
| Coronary angiography, n (%) | 39 (35.5) | 2 (14.3) | 0.20 |
| Coronary angioplasty, n (%) | 12 (10.9) | 0 (0) | 0.42 |
| Amiodarone, n (%) | 32 (29.1) | 7 (50.0) | 0.11 |
| Lidocaine, n (%) | 6 (5.5) | 2 (14.3) | 0.49 |
| External cardioversion, n (%) | 2 (1.8) | 1 (7.1) | 0.77 |

Abbreviations: see Table 1

**Table 4.** Comparison of patients with and without coronavirus disease 2019 (COVID-19) during the pandemic era

| | Non-COVID-19 n = 110 | COVID-19 n = 14 | *P*-value |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Symptoms not related to ICD/CRT-D discharge, n (%) | 35 (31.8) | 10 (71.4) | 0.009 |
| C-reactive protein, ng/ml, median (IQR) | 2.7 (0.6-8.2) n = 103 | 13.4 (1.9–36) n = 14 | 0.007 |
| Potassium (mEq/l), median (IQR) | 4.1 (3.8–4.3) n = 107 | 4.1 (3.8–4.4) n = 14 | 0.87 |
| NT-proBNP, pg/ml | 1988 (622-4958) n = 97 | 4253 (1463-6834) n = 14 | 0.11 |
| IHD, n (%) | 72 (65.5) | 8 (57.1) | 0.75 |
| HCM, n (%) | 6 (5.5) | 3 (21.4) | 0.10 |
| DCM non-IHD, n (%) | 29 (26.4) | 3 (21.4) | 0.94 |
| Long QT, n (%) | 2 (1.8) | 0 | 0.54 |
| AF, n (%) | 72 (65.5) | 11 (78.6) | 0.50 |
| DM, n (%) | 37 (33.6) | 3 (21.4) | 0.54 |
| CKD, n (%) | 21 (19.1) | 2 (14.3) | 0.94 |
| COPD, n (%) | 6 (5.5) | 1 (7.1) | 0.72 |
| Stroke, n (%) | 15 (13.6) | 0 (0) | 0.30 |
| Cancer, n (%) | 10 (9.1) | 0 (0) | 0.51 |

Abbreviations: AF, atrial fibrillation (chronic, paroxysmal, persistent); CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus, NT-proBNP, N-terminal pro-B-type natriuretic peptide; other — see Table 1

**Table 5.** Univariable Cox regression analysis for median-term survival

| | Variable | HR (95% CI) | *P*-value |
|---|---|---|---|
| Demographics | Age (1 year) | 1.038 (1.017–1.060) | <0.001 |
| | Male gender | 1.399 (0.740–2.643) | 0.30 |

| | | | |
|---|---|---|---|
| Studied period | Pandemic period | 0.793 (0.485–1.297) | 0.36 |
| Location | University Hospital | 1.133 (0.713–1.802) | 0.60 |
| Symptoms before and during CV | Lack of symptoms preceding CV | 0.397 (0.256–0.617) | <0.001 |
| | TLOC at CV | 0.999 (0.515–1.939) | 0.10 |
| | Pain before CV | 0.567 (0.179–1.797) | 0.34 |
| | Dyspnea | 3.069 (1.887–4.991) | <0.001 |
| | Fatigue | 2.158 (1.230–3.785) | 0.007 |
| | Infection | 1.872 (0.900–3.891 | 0.09 |
| | Bleeding | 7.348 (2.658–20.319 | <0.001 |
| | Diarrhea | 7.334 (3.126–17.208) | <0.001 |
| Probable cause | Acute heart ischemia | 0.570 (0.140–2.319) | 0.43 |
| | Heart failure decompensation | 4.376 (2.445–7.831) | <0.001 |
| | Electrolytes imbalance | 1.656 (0.721–3.807 | 0.24 |
| | Secondary prevention | 1.067 (0.808–1.408 | 0.65 |
| HVT details | HVT total number | 0.970 (0.915–1.029) | 0.31 |
| | Inappropriate HVT | 0.823 (0.491–1.377) | 0.46 |
| Disease underlying ICD/CRT-D implantation | Ischemic cardiomyopathy | 1.123 (0.696–1.813) | 0.634 |
| | Non-ischemic | 1.001 (0.608–1.648) | 0.10 |

| | | | |
|---|---|---|---|
| | HCM | 1.042 (0.328–3.310) | 0.94 |
| Concomitant diseases | CKD | 1.364 (0.788–2.360) | 0.27 |
| | DM | 1.978 (0.618–1.549) | 0.93 |
| | COPD | 2.112 (1.116–3.997) | 0.02 |
| | Cancer | 2.975 (1.477–5.990) | 0.002 |
| | Stroke | 0.896 (0.448–1.793) | 0.76 |
| Echocardiography | EF | 0.943 (0.920–0.967) | <0.001 |
| Medical history | Heart failure decompensation | 2.886 (1.860–4.478) | <0.001 |
| | AF/AFL | 1.875 (1.146–3.067) | 0.01 |
| | RBBB | 0.439 (0.578–3.577) | 0.43 |
| | LBBB | 2.232 (1.269–3.924) | 0.005 |
| ECG at admission | AF | 1.393 (0.896–2.164) | 0.14 |
| | VT | 2.431 (0.979–6.033) | 0.06 |
| In-hospital procedures | Ventricular ablation | 0.930 (0.503–1.718) | 0.82 |
| | Supraventricular ablation | 0.435 (0.060–3.125) | 0.41 |
| | Coronary angiography | 0.784 (0.495–1.241) | 0.30 |

| | | | |
|---|---|---|---|
| | Coronary angioplasty | 0.487 (0.197–1.203) | 0.12 |
| | Amiodarone | 1.710 (1.092–2.677) | 0.02 |
| | Lidocaine | 1.086 (0.342–3.445) | 0.90 |
| | External cardioversion | None patient who had external cardioversion died, HR could not be calculated | |

Abbreviations: AFL, atrial flutter; CI, confidence interval; CV, electrical shock; HR, hazard ratio; HVT, high-voltage therapy; LBBB, left bundle branch block; RBBB, left bundle branch block; TLOC, transient loss of consciousness; VT, ventricular tachycardia; other — see Tables 1 and 4

**Table 6.** A stepwise multivariable Cox regression analysis for survival in the model 1 (only the parameters related to the last visit of the given patient were analyzed)

| | HR (95% CI) | *P*-value |
|---|---|---|
| Age (per year) | 1.025 (1.001–1.049) | 0.045 |
| EF (per 1%) | 0.953 (0.928–0.979) | <0.001 |
| Cardiac decompensation in MHx | 1.960 (1.185–3.244) | 0.009 |

Abbreviations: EF, ejection fraction; MHx, medical history; other — see Table 5

**Table 7.** The stepwise multivariable Cox regression analysis for survival in the subgroup of patients who had the last visit during pandemic period in the model 3 (only the parameters related to their last visit were analyzed)

| | HR (95% CI) | *P*-value |
|---|---|---|
| SARS-CoV-2 infection | 3.604 (1.322–9.822) | 0.012 |
| Age (per year) | 1.052 (1.006–1.100) | 0.025 |
| Cardiac decompensation in MHx | 2.600 (1.137–5.947) | 0.025 |

Abbreviations: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; other — see Tables 5 and 6