Original Article

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Comparison of Code Blue Practices Between the First Year of COVID-19 and the Previous Year

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Abstract

Aim: After the coronavirus disease-2019 (COVID-19) infection was declared a pandemic, there were some changes made to the code blue and resuscitation practices. We compared code blue practices between the first year of COVID-19 and the previous year.

Methods: We accepted the pre-pandemic (group 1) period from March 11th, 2019 to March 11th, 2020, and the post-pandemic (group 2) period from March 11th, 2020 to March 11th, 2021. The study was designed as a cross-sectional study. We investigated the incidence of code blue, the unit where the call was made, the team's time of arrival, the return of spontaneous circulation (ROSC), the duration of cardiopulmonary resuscitation, and the general outcomes. We analyzed the 6 month follow-ups of the patients.

Results: There was an increase in the incidence of code blue in group 2 (0.4-0.9%). The two groups showed a significant difference in the time of arrival, ROSC, and 1 month and 6 month survival. The ROSC rate and 1 month survival were lower in COVID-19 patients ($p<0.001$). Six month survival was lower in COVID-19 patients ($p=0.031$). We identified 63 faulty calls, and 38 of these patients died within 6 months.

Conclusion: The faulty code blue calls may be a predictor of poor prognosis, and early warning systems should be developed for patients with poor conditions.

Keywords: Code blue, cardiopulmonary resuscitation, COVID-19, survival rate

Introduction

The aim of code blue is to provide a rapid and organized response to medical emergencies by dedicated teams (1). When this call is made, healthcare professionals apply cardiopulmonary resuscitation (CPR) to individuals whose basic life functions (respiration and circulation) have stopped. Some cases that do not require CPR may be incorrectly identified as code blue. According to research, faulty code blue calls may be a predictor of poor prognosis (2,3). The implementation of code blue involves preparing a professional team, equipment, a technological call system, the time of arrival, effective intervention, a post-intervention period, and taking records (4).

After the coronavirus disease-2019 (COVID-19) infection was declared a pandemic in March 2020 (5), there were some changes made to the code blue and resuscitation practices. The World Health Organization (WHO) accepted CPR as an aerosol-generating procedure (due to the high aerosol spread during chest compressions and airway manipulations) and ranked rescuer safety as a priority in the updated guidelines (5-8).

Since rescuers needed to wear personal protective equipment (PPE) before resuscitation during the COVID-19 pandemic, significant delays were expected in performing CPR, estimating much lower survival rates (9,10). Research has shown lower survival rates after cardiac arrest in COVID-19 patients compared to other patients (11). However, previous studies have not mentioned faulty code blue calls in detail. This could stem from the fact that

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the severity of the pandemic may have differed among countries.

In this study, we compared the incidence and outcomes of code blue practices between the first year of the COVID-19 pandemic and the previous year, including faulty code blue calls.

Materials and Methods

Compliance with Ethical Standards

This research was conducted in a 1500-bed tertiary education and research hospital, designated for the COVID-19 pandemic. We adhered to the principles of the Declaration of Helsinki and obtained approval from the University of Health Sciences Turkey, Bursa Yuksek Ihtisas Training and Research Hospital Clinical Research Ethics Committee (2011-KAEK-25 2021/03-25) and the COVID-19 Scientific Research Platform (2021-03-17T14-23-31).

Study Design

This study was designed as a cross-sectional study. We analyzed the data based on Code Blue Notification Forms filled in from March 11th, 2019 to March 11th, 2021, and by accessing patient data from the hospital records. We designated the pre-pandemic (group 1) period as from March 11th, 2019 to March 11th, 2020, and the post-pandemic (group 2) period as from March 11th, 2020 to March 11th, 2021. The exclusion criteria were patients younger than 18 years and out-of-hospital code blue calls. We obtained the incidence of code blue calls, the date and time of events, patients' age, sex, and current diseases, the unit where the call was made, the units that participated in code blue, the team's time of arrival, the duration of CPR, the accuracy of the call, and the outcomes of the practice. We also examined 1 month and 6 month survival. Faulty calls were defined as those that did not require basic life support or advanced life support based on the Utstein Style (3). Faulty code blue calls were not excluded from investigating their outcomes. Patients who were not hospitalized and who applied for outpatient diagnosis and treatment were defined as outpatients. The team's time of arrival was accepted as the time between making the call and the team taking over the patient. The code blue dates and times were divided into two groups: working hours (8 am to 4 pm) and non-working hours (4 pm to 8 am on weekdays and all day on weekends). Holidays and public holidays were considered non-working hours.

Pandemic Measures

During the pandemic, some measures were taken and changes were made at our institution. To meet the increasing demand, inpatient services were reorganized; most were converted to COVID-19 units. The hospital personnel were assigned to these units on a rotational basis. COVID-19-positive patients and suspected patients were admitted to isolation wards. The criteria for suspected patients often consisted of clinical findings (acute respiratory disease) and epidemiological risk factors. Also, in our institution, patients with respiratory symptoms or fever were tested for COVID-19, then admitted to the isolation ward until their tests were negative. The staff who worked in these services used PPE for COVID-19. Besides, the use of surgical masks was mandatory in all other clinical areas.

Our Code Blue Practice

Pre-pandemic: Code blue can be given to all patients, patient relatives, or hospital staff who develop cardiopulmonary arrest in inpatient services, polyclinics, laboratories, imaging centers, and all waiting areas on the hospital campus. Code blue calls are not made from emergency rooms, operating rooms, or intensive care units, since the teams in these units must already have the skills and equipment for immediate resuscitation when necessary. The calls are made via a telephone line reserved for the code blue system. In our hospital, any healthcare personnel (doctor, nurse, or auxiliary personnel like healthcare worker or patient carrier) can give the code blue when necessary. Emergency bags and all the equipment needed for resuscitation are available on all floors of the hospital. Also, when the code blue is given, an anesthesia technician and a nurse arrive with their own emergency bag. The code blue team consists of anesthesia and intensive care physicians or internal medicine physicians, anesthesia technicians, and nurses. All healthcare personnel in the hospital are given theoretical and practical CPR training once a year by anesthesiology and reanimation specialists.

Post-pandemic: In our country, the first COVID-positive case was detected on March 11th, 2020. The WHO declared the pandemic on the same day and different code blue lists were created for pandemic services and other clinics. To shorten the time of arrival, the doctors working at the pandemic units were assigned as the code blue personnel. Therefore, all branch doctors were included in the code blue teams, and CPR training was carried out online during the pandemic.

Statistical Analysis

The statistical data was analyzed using SPSS Statistics for Windows version 20.0, 2011 (Armonk, NY: IBM Corp.). The normality of data distribution was tested with the Kolmogorov-Smirnov test, and non-normally distributed continuous variables were tested using the Mann-Whitney U test. The categorical data was analyzed using Pearson's chi-squared test or Fisher's exact test

(where appropriate). The chi-squared Goodness-of-fit test was used to analyze the monthly distribution of code blue cases. With a value of <5% for the probability of the null hypothesis, the alternative hypothesis was accepted.

Results

In our hospital, 54,400 patients were hospitalized in group 1 and 28,500 patients in group 2, with 236 and 267 code blue calls, respectively (Figure 1). In group 2, hospitalizations decreased by 47.6%, while the incidence of code blue increased from 0.4% to 0.9%. In this group, 66.3% of the patients for whom code blue was given were hospitalized in the COVID-19 ward. The months of November and December marked a significant increase in the number of code blue calls for group 2, both in comparison to the other months and the whole pre-pandemic period (p<0.05) (Figure 2).

There were significant differences between the two groups in terms of the team's time of arrival, return of spontaneous circulation (ROSC), and 1 month and 6 month survival after code blue (Table 1). There was no significant difference in terms of other parameters. ROSC and 1-month survival were significantly higher in group 1 (p<0.001). Six month survival was again significantly higher in group 1 (p=0.006). The mean time of arrival was longer in group 2 (p<0.001). The most common comorbidities were malignancy and neurological diseases in group 1 (p<0.001, p=0.017, respectively) and pneumonia and hypertension in group 2 (p<0.001, p=0.025, respectively) (Table 1).

Among code blue cases, we found no difference between the patients hospitalized in the COVID-19 wards and those in other services in terms of age, sex, or time of code blue (Table 2). However, the time of arrival was significantly longer in the COVID-19 services (p<0.001). ROSC and 1 month survival rates were lower in COVID-19 patients than in other patients (p<0.001). Again, 6 month survival was lower in COVID-19 patients (p=0.031).

In this study, the 3 units that most frequently participated in code blue were internal medicine, anesthesia and reanimation, and general practitioners (Figure 3). The 3 units with the highest CPR success were anesthesia and reanimation (55.2%), neurology (50.0%), and general surgery (46.4%). The lowest rates were in neurosurgery (9.1%), ear-nose-throat (0.0%), and orthopedics and traumatology (26.3%) (Table 3).

There were 63 faulty code blue calls, and 38 of these patients were detected to have died within 6 months. There were 42 faulty code blue calls in group 1 and 21 in group 2 (Table 4). The mean age of the patients was lower in group 1 (p<0.001). Also, 50% of the patients in this group were outpatients (p=0.002). In group 2, 52% of the patients who were given a faulty code blue call were COVID-19 patients, 57.1% of which were given during non-working hours (p=0.012). We found that 76.2% of the patients in group 1 and 28.6% of those in group 2 died within 6 months after the faulty code blue calls.

Table 1. Characteristics and outcomes of code blue cases in the pre-and post-pandemic period

	Group 1 (n=190)	Group 2 (n=241)	p-value
Age, Years; med (min.-max.)	74 (18-96)	75 (24-96)	0.157
Gender, Male; n (%)	108 (56.8%)	134 (55.6%)	0.845
Calling time, out of working hours; n (%)	137 (72.1%)	159 (66.0%)	0.176
Time to arrival; minutes; med (min.-max.)	1 (1-3)	2 (1-5)	<0.001*
CPR time; minutes	30 (3-100)	35 (0-70)	0.137
ROSC; n (%)	101 (53.2%)	68 (28.2%)	<0.001*
Survival at the 1st month (%)	44 (23.2%)	18 (7.5%)	<0.001*
Survival at the 6th month (%)	18 (9.5%)	7 (2.9%)	0.006*
Comorbidities			
Pneumonia	25 (13.8)	146 (62.1)	<0.001*
Malignancies	58 (32.0)	33 (14.0)	<0.001*
COPD	18 (9.9)	26 (11.1)	0.710
Diabetes mellitus	52 (28.7)	77 (59.7)	0.370
Hypertension	59 (31.1)	104 (43.2)	0.025*
Renal disease	21 (11.6)	42 (17.9)	0.077
Heart disease	51 (26.8)	83 (34.4)	0.137
Neurologic disease	39 (21.5)	30 (12.8)	0.017*
Other	32 (17.7)	9 (3.8)	<0.001*

*p<0.05. Mann-Whitney U test, chi-square test.
CPR: Cardiopulmonary resuscitation, ROSC: Return of spontaneous circulation, COPD: Chronic obstructive pulmonary disease, min.: Minimum, max.: Maximum, med: Median

Table 2. Characteristics and outcomes of code blue cases in COVID-19 patients			
	COVID-19 services n=160	Other services n=271	p-value
Age, Years; med (min.-max.)	76 (24-96)	74 (18-96)	0.950
Gender, Male; n (%)	86 (53.8)	156 (57.6)	0.482
Time to arrival; minutes; med (min.-max.)	2 (1-5)	1 (1-5)	<0.001*
ROSC; n (%)	36 (22.5)	133 (49.1)	<0.001*
Survival at the 1st month; n (%)	8 (5.0)	54 (19.9)	<0.001*
Survival at the 6th month; n (%)	4 (2.5)	21 (7.7)	0.031*

*p<0.05. Mann-Whitney U test, chi-square test
CPR: Cardiopulmonary resuscitation, COVID-19: Coronavirus disease-2019, ROSC: Return of spontaneous circulation, min.-max.: Minimum-maximum, med: Median

Table 3. Survival percentages of all patients after the code blue according to attending physicians' medical specialties				
	n	Successful CPR	Survival at the 1st month	Survival at the 6th month
Internal Medicine*	106	41 (38.7)	17 (16.0)	**8 (7.5)**
Anesthesiology and Reanimation	76	42 (55.2)	17 (22.4)	**7 (9.2)**
Family Medicine*	53	21 (39.6)	4 (7.5)	**2 (3.8)**
Orthopedics and Traumatology	38	10 (26.3)	1 (2.6)	**0 (0.0)**
General Surgery	28	13 (46.4)	7 (25.0)	**1 (3.6)**
Ear-Nose-Throat	23	3 (13.0)	0 (0.0)	**0 (0.0)**
Urology	23	10 (43.5)	3 (13.0)	**2 (8.7)**
Other*	23	8 (34.8)	4 (17.4)	**2 (8.7)**
Neurology	22	11(50.0)	5 (22.7)	**2 (9.1)**
Cardio-Thoracic*	18	5 (27.8)	3 (16.7)	**1 (5.6)**
Neurosurgery	11	1 (9.1)	0 (0.0)	**0 (0.0)**
Obstetrics and Gynecology	10	4 (40.0)	1 (10.0)	**0 (0.0)**
Total	431	169 (39.2)	62 (14.4)	**25 (5.8)**

Data are presented as n (%).
*indicates the compressed groups of medical specialties. Internal Medicine and Infectious Diseases and Clinical Microbiology were grouped as "Internal Medicine"; Family Medicine and General Practitioner were grouped as "Family Medicine"; Physical Therapy and Rehabilitation, Ophthalmology, Pathology, Medical Ecology and Hydroclimatology, and Psychiatry were grouped as "Other"; Cardiology, Chest Diseases, Cardiovascular Surgery, and Thoracic Surgery were grouped as "Cardio-Thoracic"

Table 4. Demographics of faulty code blue patients			
	Group 1 (n=42)	Group 2 (n=21)	p-value
Age, Years; med (min.-max.)	39.5 (21-90)	70 (22-93)	0.001*
Gender, Male; n (%)	25 (59.5)	10 (47.6)	0.427
COVID-19 (+); n (%)	N/A	11(52)	N/A
Outpatient; n (%)	21 (50.0)	2 (9.5)	0.002*
Calling time, out of working hours; n (%)	10 (23.8)	12 (57.1)	0.012*
Survival at the 6th month; n (%)	32 (76.2)	6 (28.6)	<0.001*

Mann-Whitney-U test, chi-square test.
COVID-19: Coronavirus disease-2019, N/A: not applicable, med: median, min.-max.: minimum-maximum

Discussion

In comparing code blue data from the first year of the COVID-19 pandemic and the previous year, we found that the incidence of code blue increased, whereas ROSC, 1 month survival, and 6 month survival decreased significantly in group 2. The number of code blue incidents in group 2 increased, particularly during November and December. It is known that the number of daily deaths peaked in these two months during the pandemic in Turkey. We believe that this reflected the increasing number of code blue incidents during November and December. During the pandemic, the number of patients having COVID-19 increased, so elective patient admissions were postponed in hospitals. During this period, there was an increased number of code blue incidents, despite a 47.6% decrease in hospitalizations. The literature reports the incidence of code blue as around 1-5/1000 hospitalizations (12,13). Here, our incidence of code blue was 3.4/1000 hospitalizations in group 1, in accordance with the literature; however, this number was more than twice that for group 2, with 8.5 calls per 1000 hospitalizations.

Research shows that the average time to start CPR ranges from 80 to 341 seconds (14-16). Starting CPR within 1.5-2 minutes has been reported to be more successful than after 5 minutes (14). Studies during the

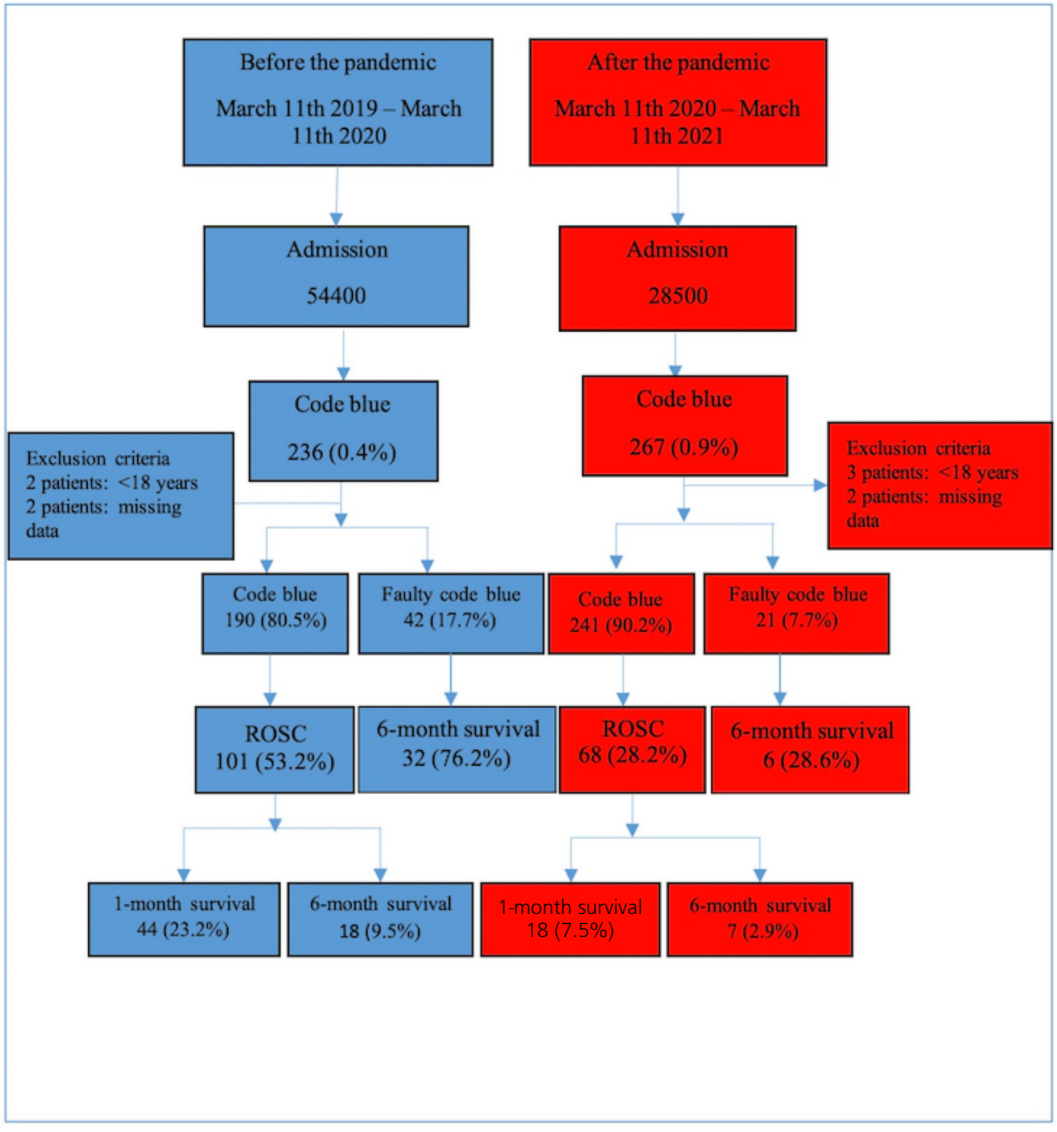

Figure 1. Workflow chart
ROSC: Return of spontaneous circulation

pandemic have suggested that wearing PPE delays CPR by up to 10 minutes (10). In this research, we observed that the mean time of arrival was longer in group 2 at 2.25±1.07 minutes. However, this time is still under 5 minutes. We associate this with the inclusion of doctors who are ready for PPE in code blue teams. In our study, we found no difference between code blue times. This indicates that the continuity of the system should be ensured both during working and non-working hours.

Studies before the pandemic report ROSC rates of 45.7-68%, while studies during the pandemic show lower ROSC rates (17-20). According to research, this result comes from the different etiology of cardiac arrest between the two periods. Before the pandemic, the most common cause was heart disease and during the pandemic it was respiratory system disease (21,22). Here, we found an ROSC rate of 53.2% in group 1, in parallel with the literature, and this rate was lower at 28.2% in group 2. The most common comorbidities were malignancy and neurological diseases in group 1 and pneumonia and hypertension in group 2. In 2010, the American Heart Association and the International Liaison Committee on Resuscitation determined the priority for CPR as chest compressions, airway, and breathing (23). Given that COVID-19 patients make up the majority of patients in group 2 and they often suffer from respiratory failure and may benefit from early ventilation, we believe that this priority should be

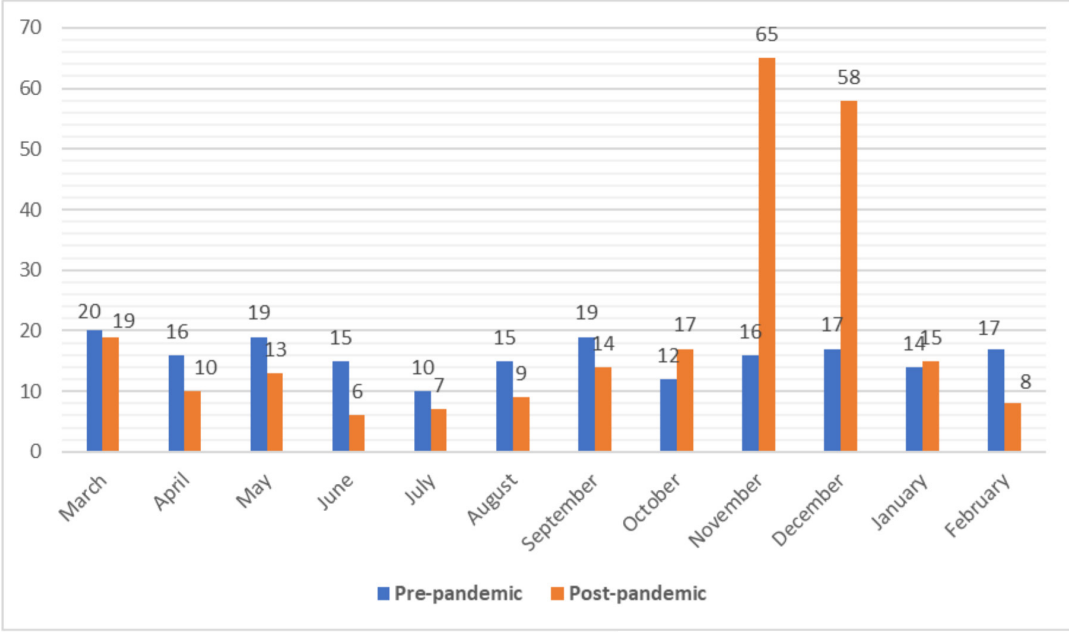

Figure 2. Bar chart of the distribution of code blue cases according to months
Footnote: The chi-square Goodness-of-fit test shows the distribution of post-pandemic code blue cases were statistically significantly different ($p<0.001$), and there was no significance in the distribution of the pre-pandemic code blue cases ($p=0.885$) according to months

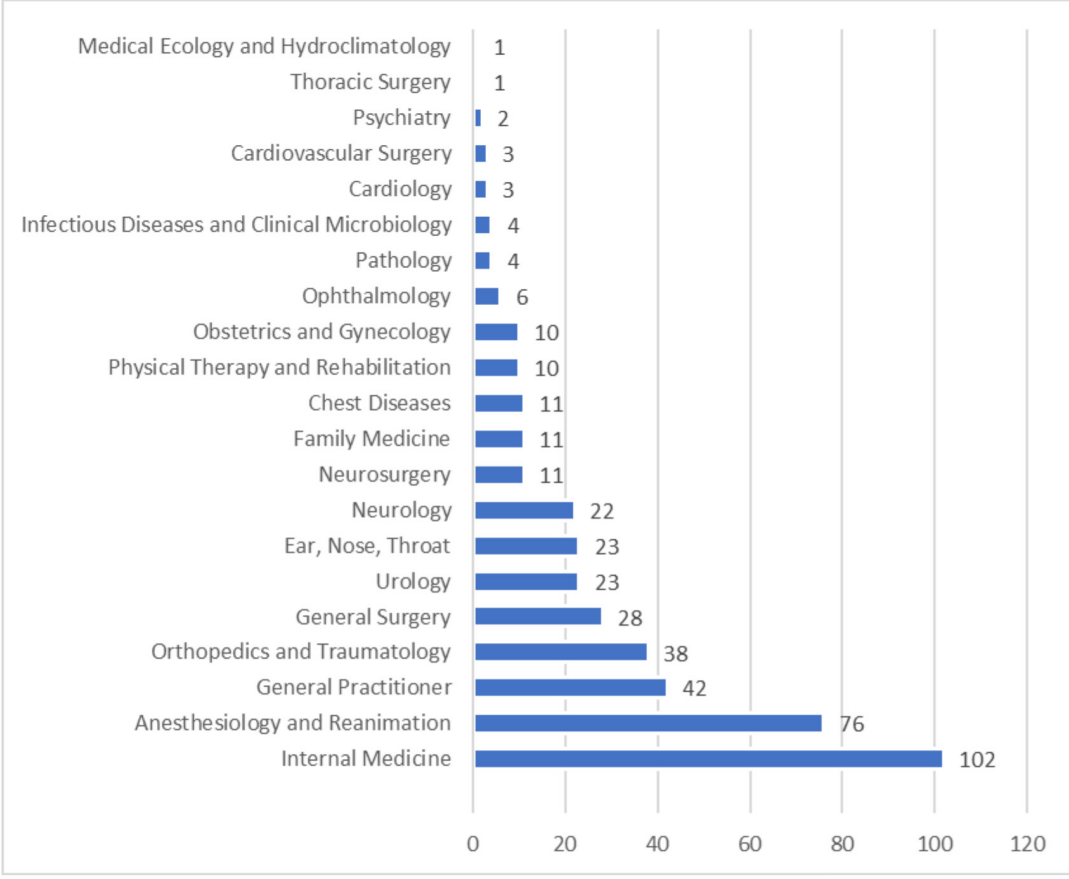

Figure 3. The distribution graphic of the physicians' medical specialties attended to code blue (n)

investigated to determine whether it is a disadvantage for COVID-19 patients.

Outcomes after IHCA vary between hospitals (24). According to the literature, studies before the pandemic reported in-hospital survival rates of 0-42% and 6-month survival rates of around 9.7% (25-27). Here, in group 2, 1-month survival decreased from 23.2 to 7.5% and 6-month survival decreased from 9.5 to 2.9%. We associate this with the fact that COVID-19 patients constituted 66.3% of all patients during the pandemic and had a poor prognosis. Still, further research is needed to increase overall survival, which is still low in all patients with cardiopulmonary arrest.

Compared with code blue patients in the COVID-19 wards with other patients, we found no difference in terms of age or sex. The time of arrival was longer with COVID-19 patients. During the pandemic, the time of arrival was expected to rise to 10 minutes (10), although we found a mean time of fewer than 5 minutes. We believe that the changes made in our code blue lists after the pandemic have influenced this finding. According to research, mortality and 1-month survival rates after code blue in COVID-19 patients were 75.0% and 2.9%, respectively (11,28). We found an ROSC rate of 22.5% and a 1-month survival rate of 5.0% in COVID-19 wards; both the 1-month and 6-month survival rates were significantly lower than those other patients. We think further research is needed on the long-term care and treatment of COVID-19 patients after a positive response to CPR.

During the pandemic, the doctors working in the code blue system were mostly from internal medicine, anesthesiology and reanimation, and family medicine clinics. After CPR and 1-month follow-up, survival rates were higher in the units of anesthesia and reanimation. We believe that there has been an increasing awareness of the importance of CPR among all doctors, regardless of the unit, during the pandemic.

In our study, we noted 63 faulty code blue calls in two years. We found the rates of these faulty calls to be 17.7% in group 1 and 7.7% in group 2. Although it is believed that faulty calls cause loss of workforce in the team, 3 of 59 patients (5%) who were given a faulty code blue call died within 6 months (3). In fact, the 1-year survival rate after a faulty call has remained the same as after CPR with VF/VT rhythm and positive response (3). We observed that 76.2% of the patients in group 1 and 28.6% of the patients in group 2 died within 6 months after a faulty call. A faulty code blue call is defined as a patient in poor condition when the call is made but one who does not develop cardiopulmonary arrest. Looking at our findings, we think patients with faulty calls may be at risk and should be investigated in detail. There have been studies on early warning systems and early intervention teams for patients with a deteriorating general condition (29,30). We believe that such practices should become widespread, as they can positively affect the number of in-hospital arrests and faulty code blue calls. In our group 1, the rate of faulty calls was higher during non-working hours. In group 2, COVID-19 patients in particular had to be followed up in isolated wards. These patients may have felt uneasy in these wards, which may have increased the rate of faulty code blue calls during non-working hours.

Study Limitations

The main limitations of this study were its single-center, retrospective design and its inability to present initial arrest rhythms, drugs used in patients, and neurological status of surviving patients due to insufficient data.

Conclusion

We compared the first year of the COVID-19 pandemic with the previous year and found increased rates of IHCA and decreased rates of ROSC, 1-month survival, and 6-month survival. We believe that faulty code blue calls may be a predictor of poor prognosis and early warning systems should be developed for patients with poor conditions. Long-term follow-up and more detailed research are needed to increase survival rates after cardiac arrest in both COVID-19 and other patients. The strength of the study is the detailed analysis of faulty blue codes.

Ethics

Ethics Committee Approval: We adhered to the principles of the Declaration of Helsinki and obtained approval from the University of Health Sciences Turkey, Bursa Yuksek Ihtisas Training and Research Hospital Clinical Research Ethics Committee (2011-KAEK-25 2021/03-25).

Informed Consent: Patient files were reviewed with the approval of the ethics committee.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Concept: N.K., D.K., M.G., Design: N.K., D.K., M.G., H.G., Data Collection and/or Processing: N.K., S.E., S.E.A., Analysis and/or Interpretation: N.K., D.K., S.E., H.G., Literature Research: N.K., S.E.A., S.E., Writing: N.K., H.G., D.K., B.O.

Conflict of Interest: No conflict of interest was declared by the authors.

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