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RESEARCH ARTICLE

Code Blue Applications in COVID-19 Pandemic Hospital

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Abstract

Objective: Code Blue (CB) is one of the important practices for preventing mortality and morbidity and increasing the quality of care in hospitals. The aim of this study was to evaluate the Code Blue notifications and their results, their importance, and determine the effectiveness and deficiencies of the applications in a pandemic hospital.

Materials and Methods: In this study, CB forms of our hospital were reviewed retrospectively. By looking at the forms, results such as demographic data, diagnosis, cardiac arrest, time and place of CB administration, time of team reaching the patient after CB administration, heart rhythm of the patient, respiratory rhythm, duration of Cardio-Pulmonary Resuscitation (CPR) applied to the patient, Endotracheal Intubation status, whether defibrillation was performed, and transfer to the intensive care unit were recorded.

Results: In the study, it was found that there were a total of 650 CB calls (2020-2022). The mean age of the patients was 60.00 (±28.51) years. The mean time to reach calls was 1.26 (1-7) minutes (min), and the mean CPR time was 15.40 ± 20.30 minutes. Looking at the units where CB calls were given, it was found that 300 (46.15%) of the calls were made from the COVID-19 service, 150 (23.07%) from the palliative care unit, and 140 (21.54%) from the neurology intensive care unit. When the appropriateness of the CB was evaluated, it was found that 585 (90%) of 650 patients were correct and 65 (10%) were incorrect CB calls. It was observed that 44% of CB was given due to cardiac arrest. CPR was performed in 286 (44%) of the patients, it was found that 364 (56%) were given advanced respiratory support without cardiac massage. In our study, the survival rate was 50% and the transfer rate to the intensive care unit was 85%.

Conclusion: It has been determined that the vital CB system is realized at an appropriate time, but the rates of incorrect CB rates are still high. It was found that the unit with the highest number of CBs was the COVID-19 Ward and the second was the Palliative Care Ward. COVID-19 infection has increased CB rates and intensive care death rates. Awareness of healthcare professionals about the indications for CB administration must be increased and they must be trained on how to approach the patient with which indication.

Keywords: Code Blue, Cardio Pulmonary Resuscitation, COVID-19, Death.

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1. Introduction

A timely and effective intervention with CPR not only saves the lives of patients but also allows them to lead functional lives by preserving their previous health status. "Code Blue" (CB) is used for CPR to be performed in a timely and effective manner. Early diagnosis and approach are very important in CPR. For this purpose, the target for the CB team to reach the scene must be identified and the actual times must be followed (1-9). Methods such as intercom system, button system, pagers and wireless phone systems are used in the CB system. Hospitals must shorten the time taken for detection and treatment before follow-ups in CPR applications by using these technological communication tools (10).

It is stated in the American Heart Association (AHA) Guideline that when a cardiopulmonary arrest occurs, the aim is to intervene in a period not exceeding two minutes and to give the first electrical shock at the end of this period (9, 11). This practice is an important standard in terms of patient safety and life risks and has become a criterion in the provision of quality healthcare in hospitals (11). CB, which is the emergency code indicated in the same color on a global scale, was used for the first time in Bethany Medical Center, Kansas, in the USA (1-9). In our present day, this organization is called "*Outreach Service*" in the UK,"*Medical Emergency Team*" in Australia,"*Rapid Response*" in the USA, and "*Code Blue*" in all other countries (8, 9).

In our country, Code Blue has been used since 2008 with the implementation of Service Quality Standards. According to the "Patient and Employee Safety Directive" that was published by the Ministry of Health of the Republic of Turkey in 2009 and in 2011, it has become mandatory to apply Code Blue in hospitals. This practice is also included in the "Hospital Service Quality Standards" within the scope of the "Performance and Quality Directive in Health" numbered 9489 dated 2011 of the Ministry of Health of the Republic of Turkey and is subject to evaluations. The use of the telephone activation call system 2222 was deemed appropriate and adopted by the Ministry of Health of the Republic of Turkey for CB to develop national terminology and for the generalization of this practice (1-9).

A CB system must be developed and service types need to be analyzed and inspected on a regular basis (1-5). An effective CB system includes the establishment of a professional team, maintaining the alertness of the team, technological call systems, making the necessary preparations until the team arrives, the arrival time of the CB team, availability of equipment, effective intervention and post-intervention management, and recording the steps of the entire system (4).

The CB system is implemented and supervised in many countries. Our aim was to increase the ergonomic use of the CB system and eliminate errors and deficiencies by examining the outcomes. In the present study that was conducted in a training and research hospital, the purpose was to identify the effects of the CB system on survival and the deficiencies in practice during the pandemic. The primary target was to evaluate the results of timely CB activation and CPR in terms of survival of patients with cardiac or respiratory arrest. The secondary objective was to identify practical issues regarding CB functioning and compare them with the current literature data.

2. Material and Method

The study was conducted with the approval of the Ethics Committee of Sadi Konuk Training and Research Hospital, University of Health Sciences. The CB team of the hospital included an anesthesiologist, an anesthesia technician, an Emergency Medical Technician (EMT), and a security guard. The management, coordination, and control of these team members are performed by anesthesiologists. When a CB notification is made, the anesthesiologist and anesthesia technician arrive at the scene with an emergency kit. CB notifications occur when the phone line that is reserved for CB activates the system. The notifications are sent to the call phones of the CB team. The pager, which acts as a receiver, allows the team to reach the location where the phone number is located. Then, CB is terminated when the team arrives at the scene. The CB team fills out the CB form after examining the patient and performing the necessary intervention.

This retrospective clinical study was conducted by reviewing the fully completed CB notification forms at Prof. Dr. Murat Dilmener Emergency and Pandemic Hospital between January 1, 2020, and December 31, 2022. The hospital has 1008 beds and a total of 432 tertiary intensive care beds. The number of intensive care beds varied throughout the pandemic depending on the need. The demographic data of the patients, preliminary diagnoses, cardiac arrest and time and place of CB, time for the team to reach the scene after CB, heart rhythm and respiratory rhythm observed in the patient after the team reached the patient, duration

of Cardio-Pulmonary Resuscitation (CPR) applied to the patient, if any, Endotracheal Intubation (ETI) status and whether defibrillation was performed were recorded from the CB forms. In statistical evaluations, the data of the study were analyzed by using the IBM SPSS Statistics for Windows (Version 22.0). The distributions of the categorical variables between the groups were evaluated with the Chi-Square Test. Also, mean ± standard deviation and median (min-max) were used as descriptive statistics for continuous measurement values in summarizing the results obtained in the study, and frequency distributions and percentages were used for categorical variables. $P<0.05$ was taken as the statistical significance limit.

3. Results

It was found that there were a total of 650 CB calls during the study period. The average age of the patients was found to be 60.00 (±28.51) years, 299 (46%) of them were female, and 351 (54%) were male. The team's average response time to the calls was 1.26±0.5 (1-7) minutes and CPR time was 15.40±20.30 minutes (Table 1).

Table 1. *The evaluation of the team's time to reach Code Blue calls and Cardio-Pulmonary Resuscitation times*

	N (Number)	Hydrangea	Min	Max	Mean	SD
CB team's arrival time (min)	650	1	1.00	7.00	1.26	0.49
CPR duration (min)	585	30	0.00	60.00	15.40	20.60

**CPR: Cardio-Pulmonary Resuscitation, CB: Code Blue, Min: minimum, Max: maximum, Mean: mean, SD: Standard Deviation*

When the units where CB calls were made were evaluated, it was found that 300 (46.15%) of the calls were made from the COVID-19 Ward, 150 (23.07%) from the Palliative Care Unit, and 140 (21.54%) from the Neurology Intensive Care Ward (Table 2).

Table 2. *The evaluation of units that made Code Blue calls*

	Number (N)	Percentage (%)
Emergency Department	60	9.23
COVID-19 Infection Ward	300	46.15
Neurology Intensive Care Ward	140	21.54
Palliative Care Unit	150	23.07

When the accuracy of Code Blue calls was evaluated, it was found that 650 (90%) were correct and 65 (10%) were incorrect. When the reasons for CB administration were examined, the most common reasons were cardiac arrest (40%) and low oxygen saturation (SpO_2) (50%) (Table 3).

Table 3. *The evaluation of the reasons for giving a Code Blue*

	Number (N)	Percentage (%)
Allergic reaction	2	0.3
Fainting	34	5.2
Epileptic seizure	20	3
Chest pain	2	0.3
Hypotension	12	1.8
Cardiac arrest	260	40
Conversion	2	0.3
Shortness of breath	48	7.3
Low oxygen saturation	325	50
Tachypnea	6	0.9
Endotracheal tube obstruction	26	4
Pneumothorax	24	3.6

The most common cardiac rhythm (46.1%) in patients with CB call was asystole and the second most common rhythm was tachycardia (32.4%). The most common breathing type in patients with CB calls was apnea (51.4%) and the second most common breathing type was tachypnea (35.1%) (Table 4).

Table 4. *Cardiac and respiratory rhythms of patients*

	Number (N)	Percentage (%)
Cardiac rhythms		
Asystole	300	46.1
Bradycardia	30	4.6
Rhythmic	110	16.9
Tachycardia	210	32.4
Respiratory rhythms		
Apnea	334	51.4
Bradypnea	4	0.6
Normal	84	12.9
Tachypnea	228	35.1
Total	650	100

When the medications administered to the patients during the Code Blue notification were evaluated, it was found that 42% were administered ephedrine, 40% atropine, 36.4% adrenaline, and 10% midazolam and 520 (80%) of these patients received CPR, while 130 (20%) did not receive CPR. Also, 455 (70%) of the patients for whom CB calls were made were intubated and 195 (30%) were not. Defibrillation was applied to 10 (1.53%) patients who needed it (Table 5). Atropine injections are used to treat symptomatic or unstable bradycardia. The Code Blue team must be able to administer IV atropine to adult patients to prevent glossopharyngeal bradycardia and reduce salivary secretion during intubation.

Table 5. *Evaluation of Code Blue results*

	Status	Number	Percentage (%)
CPR	Yes	520	80
	No	130	20
Intubation	Yes	455	70
	No	195	30
Defibrillation	Yes	10	1.53
	No	640	98.47

**CPR: Cardio-Pulmonary Resuscitation.*

The survival rate was found to be 50% in the present study and the transfer rate to intensive care was 85% (Table 6).

Table 6. *Clinical results of the patients after Code Blue*

	Patient status	Number (s)	Percentage (%)
Mortality	Yes	325	50
	No	325	50
Transfer to Intensive Care Unit	Yes	550	85
	No	150	15
Discharge from Intensive Care Unit	Yes	165	30
	No	385	70

4. Discussion

It has been reported in previous studies evaluating patients undergoing CB in the adult population that the average age was generally over 65 years (8, 9, 12-18). In the study conducted by Özütürk et al. (1), the average age of the patients who underwent CB was reported as 54.1 years. In our study, the average age of the patients was 60.00 (±28.51) years.

Studies conducted in our country reported different arrival times for CB teams (1, 7, 10, 14, 15, 16, 17, 18, 21, 23, 24, 25). It was reported in different studies that the average time to start CPR varied between 80 seconds and 341 seconds (1, 17-20). In our study, the average time to reach the CB notification area was found to be 1.26 minutes (1min-7min). Ideally, the time to reach the CB notification area is 0-3 minutes. Our clinical study shows that we are successful in terms of the standards. It has been shown that CPR intervention in less than three minutes increases the

survival rate when compared to later intervention (13, 17-22). When the data from the years when the application of CB started to become widespread with the notifications (2008 and before) were evaluated, it was found that the time to reach CB, which was 4-8 minutes, has become shorter in our present day.

When the service areas where Code Blue calls were most frequently given were evaluated, it was seen that the data varied in studies. In their study, Kayır et al. did not detect any statistical significance between services in terms of the number of calls reported (24). However, in this study, the department where CB calls were most frequently made numerically was the palliative care ward, followed by the internal medicine ward, oncology, and surgery wards (24). Özmete et al. (17) reported that the CB calls were made mostly from internal medicine intensive care unit (72.1%), Arıkan et al. (16) from the palliative care unit (33.78%), Çiçekçi et al. (25) from cardiology intensive care unit (29.2%), Özgür et al. (14) from the chest diseases clinic (52.1%), and Özütürk et al. (1) found that the highest number of CB notifications came from the emergency department (92.4%). In our study, it was found that 300 (46.15%) of the calls were from COVID-19 Infection Wards.

Basic and advanced life support training must be provided to all healthcare staff in theoretical and practical applications for the CB team to work effectively and efficiently in hospitals. Initiating Code Blue notifications by unconscious and unauthorized people without evaluating the patient causes incorrect calls. When the false Code Blue rates were evaluated in various studies, Arıkan et al. (16) reported it to be 13.33% and Mehel et al. (22) reported 6% incorrect calls. Kayır et al. (24) reported that this rate varied between 4-31% depending on the year. Eroğlu et al. (11) reported in their study that 91% of the Code Blue calls were incorrect in their hospitals. They interpreted the reason for the incorrect calls as the patient density and staff differences in the hospital where the study was conducted. This rate was found to be 10% in our study. The reason for this low rate can be interpreted as the effectiveness of CPR training given at the beginning of employment and on an annual basis thereafter. Correct operation of the CB call system, minimizing workforce loss, and increasing the motivation of the CB team can reduce false call rates.

According to the third article of the CB Practices published by the Ministry of Health in the Official Gazette on 26 April 2009 with the number 27214, the obligation to fill out the Code Blue form was eliminated with the statement "Code Blue warning is not given in units such as emergency rooms, intensive care units, and operating rooms, which will be determined by the administration and where CPR application is frequently required, and the necessary interventions for patients treated in these units are carried out within the unit. For this purpose, it is stated that "CPR and/or basic and advanced life support training is provided for the staff working in these units" (26).

The high CB call rates can be reduced by training activities and increasing awareness. It has been emphasized in the literature that simple knowledge and skills improve within 1-6 months in people who receive CPR training (28, 29). Guides on this subject also emphasize the importance of training. For this reason, it is important to provide CB and CPR training in hospitals (1, 29).

Sağlam Gürmen et al. (29) reported the reasons for CB calls as cardiopulmonary arrest, hypotensive attack, hypoglycemic attack, anxiety, feeling sick, syncope, labor, palpitations, chest pain, seizure, and falls. In our study, when the reasons for CB administration were evaluated, the most common were cardiac arrest (40%) and low SpO_2 (50%).

When the cardiac rhythms of patients with CB calls were evaluated, it was seen that differences were reported in various studies. In our study, asystole was the most common cardiac rhythm with a rate of 46.1%. Similarly, asystole was reported by Özgür et al. (14) as 54%, Çiçekçi et al. (25) reported it as 47%, Özmete et al. (17) reported it as 87%. Gürmen et al. (29) performed a study and applied cardiac massage and subsequent intubation on three patients diagnosed with pulseless ventricular tachycardia and three patients diagnosed with myocardial infarction along with medical cardioversion to four patients and defibrillation to three of seven patients diagnosed with arrhythmia. In our study, it was found that out of 20 patients who were diagnosed with arrhythmia, 10 (1.53%) underwent medical cardioversion (amiodarone intravenous treatment), 10 (1.53%) underwent defibrillation, and 20 (3.06%) patients who had MI (Myocardial Infarction) underwent cardiac massage and then intubation.

Survival rates varied according to centers in previous studies and reported as 56% by Özgür et al. (14), 34% by Koltka et al. (20), 47% by Murat et al. (12), 62% by Mehel et al. (22), 55.6% by Arıkan et al. (16), 61% by Özütürk et al. (1), and 95% by Yılmaz et al. (21). In our study, the survival rate was found to be 50% after CPR within 2 years. This low survival rate was caused by the COVID-19 pandemic.

The most common complication of COVID-19 infection was pneumonia in hospital admissions (79.1%), followed by ARDS (3.37%) and shock (1%), although acute kidney injury, rhabdomyolysis, and disseminated intravascular coagulation were reported less frequently. The most common complication was pneumonia in our pandemic hospital (46.15%), followed by ARDS (20%) and shock (2%). Mortality due to severe pneumonia was also independently associated with intensive care monitoring, mechanical ventilation, and death (30). Coagulopathy and thrombocytopenia are common complications of COVID-19 infection that increase the risk of bleeding and thrombosis. Petechial or purpuric rash, melena, and hematuria may also be observed in some cases. The possibility of Pulmonary Thromboembolism (PTE) must be suspected in patients with persistent hypoxemia, chest pain, pre-syncope, syncope, and hemoptysis (31). The rate of first hospitalization with pneumonia and primary respiratory distress was found as 46.15% in Prof. Dr. Murat Dilmener COVID-19 Pandemic Hospital.

SARS-CoV-2 causes accumulation of Angiotensin-2 in the host organism stimulating the Angiotensin II Type 1 Receptor (AT1R) and causing vasoconstriction, inflammation, fibrosis, hypertrophy, vasospasm, endothelial dysfunction, platelet aggregation, increased vascular resistance and apoptosis. These negative effects increase pulmonary vascular permeability and cause lung damage, as well as impairing cardiac nutrition by causing coronary vein occlusion (32). The high rates of admission to intensive care units because of pneumonia and MI coincided with this mechanism in the present study.

Atropine injections are used to treat symptomatic or unstable bradycardia. Atropine was previously included in international resuscitation guidelines to be used in cardiac arrest associated with asystole and PEA but was removed from these guidelines in 2010 because of a lack of evidence regarding its effectiveness [21]. The usual dosage is 0.5 to 1 mg IV push for symptomatic bradycardia, which may be repeated every 3 to 5 minutes up to a total of 3 mg (maximum 0.04 mg/kg) [22].

Atropine is useful in treating Second-Degree Mobitz Type 1 Heart Block (Wenckebach Block) as well as Third-Degree Heart Block with elevated Purkinje or AV Node Escape Rhythm. It is generally not effective in Second-Degree Mobitz Type 2 Heart Block and in Third-Degree Heart Block in which the Purkinje or Ventricular Escape Rhythm is decreased. Atropine has also been used to prevent low heart rates during intubation of children, but the evidence does not support such a usage [23].

The effects of Atropine on the parasympathetic nervous system inhibit the salivary and mucous glands. The drug may also inhibit sweating over the sympathetic nervous system, which may be useful in treating hyperhidrosis and may prevent the death wheeze of dying patients. Although Atropine is not officially indicated by the FDA for any of these, it is still used by physicians for these purposes [24].

CPR training is provided by the Anesthesiology and Reanimation Clinic to all employees three times a year. CB trainings are not included in this program. All healthcare staff must be trained for basic life support and correct in-hospital CB calls.

The limitations of the present study were some deficiencies in the recorded data and the single-center design of the study. Being a pandemic hospital also increased the death from pneumonia rates.

In conclusion, it was found that the vital CB system was performed in our hospital at an appropriate time, the rate of incorrect CB was low, and the COVID-19 pandemic increased mortality rates after CPR. Making healthcare professionals more aware of CB indications will increase survival after CPR.

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