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Code blue applications as an indicator of clinical quality

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ABSTRACT

Objective: To investigate the code blue application at a training and research hospital in Turkey.

Methods: The code blue declaration forms and the hospital database with 238 complete records between January 2016 and July 2017 were collected. The form involved individual characteristics, the reason for issuing the code blue call, the unit and block where the code was given, time and location related properties such as working time and arrival duration, properties regarding the intervention process such as its type, duration or result. The 24-hour and 30-day long survival data of the patients to whom cardiopulmonary resuscitation was implemented were obtained from the hospital database, or from their relatives. The influencing factors of arrival duration were analyzed.

Results: The median duration of arrival was 2.14 (2.00-3.02) min. Code blue applications were performed more frequently in Departments of General Surgery, Internal Medicine, Orthopaedics, and Cardiology Clinics. Half of the code blue calls were due to cardiac arrest; the other half was due to shortness of breath or respiratory distress, syncope, and respiratory arrest. Three-out-of four code blue calls were treated with orotracheal intubation and cardiopulmonary resuscitation, or only orotracheal intubation or only medical treatment; one-fourth of the calls were not intervened. Altogether, 72.36% of the code blue calls patients were intervened; 69.35% of them were made both orotracheal intubation and cardiopulmonary resuscitation, and 20.5% of them were made only orotracheal intubation and 10.55% of them made only medical treatment. It was found that giving the code blue day or night had no effect on the time to reach the area where the code was given. Similarly, it was found that giving the code blue within daytime or night shift had no effect on the time to reach the area where the code was given. (P>0.05). The survival rates were 39.1% within the first 24 h and 18.1% within the first 30 d.

Conclusions: Applications of code blue should be analyzed at regular intervals as clinical quality indicators. Reasons for wrong calls should be determined. The duration of reaching locations where calls are made should also be decreased.

KEYWORDS: Code blue; Cardiopulmonary resuscitation; Heart arrest; Respiratory arrest; Paging system

1. Introduction

Hospital emergency codes are used to alert staff in various emergency situations in hospitals around the world. The use of codes aims to create a common language for emergencies and to communicate quickly to hospital staff with minimal misunderstanding between staff[1]. The “code blue” (CB) is a system that provides hospital-wide response and is often used to identify a patient who requires resuscitation or emergency medical attention as a result of respiratory or cardiac arrest[2,3].

The implementation of rapid response systems in health care facilities to enhance patient safety is strongly supported by quality improvement organizations such as the Institute for Health Services Development and recommended in international guidelines[4]. Similarly, Joint Commission International-the accreditation organization for independent health facilities, and USA Institute of Healthcare Improvement also recommend actions intended for regular measurement and rehabilitation in cases of sudden cardiac arrest and cardiopulmonary resuscitation (CPR), along with standard and rapid intervention methods such as CB and rapid response system[5-7].

The application of CB was first used in the USA[8]. In Turkey,

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it was first used in 2008 at a professional level within the scope of the Hospital Service Quality Standards published in 2008; it was made obligatory with the bulletin issued in 2009, and the Patient and Staff Safety Regulations which were enforced in 2011. A CB team comprises a physician, a nurse, an anesthetist, a janitor, and a security guard[9,10].

CB is an important indicator with respect to the quality of health services and is an important standard with regard to patient safety and survival[6]. Only 20% of the patients who suffered cardiac arrest in a hospital were discharged to go home[7]. A study was conducted using the UK national cardiac arrest database, and 22.628 anamneses from 144 hospitals were examined, which belong to patients with resuscitation performed through a CB call. It was determined that 1.6 cardiac arrest cases occurred in every 1 000 hospitalization cases, and the discharge rate was found to be 18.4%. It was also observed that the discharge rates varied significantly among different hospitals[11]. In 16 studies conducted by The American Heart Association based on a database encompassing 358 hospitals between 2000 and 2009, and involving cases of cardiac arrests developed within the hospitals, it was determined that 4.02 cases occurred for every 1 000 hospitalization cases and the discharge rate was 18.8%[12-19].

This study aimed to determine the effectiveness of CB applications as a clinical quality indicator. Also, it is aimed to examine retrospectively the cases in which CB calls were given in order to ensure the renewal of the early notification forms through detecting the failing aspects of the applications if there are.

2. Materials and methods

2.1. Samples

This study was conducted in Bakirkoy Dr. Sadi Konuk Training and Research Hospital in Istanbul, Turkey, between January 2016 and July 2017. The hospital has a total capacity of 750 beds and provides health treatment and care services to approximately one million people. During the study period, 283 CB calls were made but 8 forms were excluded from the study due to incomplete data. Therefore, the study was carried out with 275 CB notification forms. These notification forms had no missing data and belonged to patients aged 10-97 year-old. Since 2009, in the hospital, the call system application, the pager with short message service, an announcement activation with phone line of which number is 2222, and a direct team telephone have been used. CB team members consist of a anesthetist or research assistant or intensive care subspecialist working on block E 1st floor, and two nurses, a janitor and a security guard working in the emergency department on block E ground floor.

The blocks are divided as follows: Block A, ground floor + 6 floors; block B, ground floor + 5 floors; block C, ground floor + 3; floors block D, ground floor + 3 floors; block E, ground floor + 4 floors. The distance between blocks E and the other blocks were: between blocks E and A, 93 m; blocks E and B, 100 m; blocks E and C, 75 m; between blocks E and D, 90 m. All blocks are designed in such a way that the elevator core is in the middle and the stairs are on both sides. On the ground floors, only polyclinic services are provided, and care services are provided to the inpatients on the upper floors.

2.2. Data collection via CB notification form

The form developed by the hospital involved individual characteristics such as age and gender (open-ended and multiple-choice questions), the reason for issuing the CB call, the unit and block where the code was given, time and location related properties such as working time and arrival duration (open and close-ended questions), properties regarding the intervention process such as its type, duration or result. The 24-hour and 30-day long survival data of the patients to whom CPR was implemented were obtained from the hospital database, or from their relatives.

2.3. Ethical considerations

The implementation was approved by Bakırkoy Dr. Sadi Konuk Training and Research Hospital Clinical Trials and Ethics Committee (2018-03-14).

2.4. Statistical analysis

The data were analyzed with SPSS 21.00 for Windows (SndowPSS, Chicago, IL, USA). The enumeration data were expressed as frequency and percentage, measurement data that were normally distributed were expressed as mean±SD, while measurable data that are not normally distributed were given as median and IQR. *Chi*-square test was performed to evaluate categorical variables. The Mann-Whitney *U* test was used for comparing the variables without normal distribution among groups, and Kruskal Wallis test was used for data with normal distribution. The level of significance was set as α=0.05.

3. Results

The demographics of patients and CB status are shown in Table 1. A total of 275 CB applications were studied during the study period. More than half of the patients (50.18%; n=138) were male, and their mean age was (65±18) years old (range 10-97 years old). There was no significant difference between genders in terms of mortality (P>0.05).The majority of all CB applications took place in block A (67.27%; n=185), during the daytime shift (08:00-16:00) (53.45%; n=147) and at out the shift change time (96.36%; n=265).

Block A showed the longest arrival duration [2.36 (2.04-2.94) min], while block B the shortest [1.96 (1.88-2.14) min], and the average duration was 2.14 (2.00-3.02) min. Altogether 199 (72.36%) patients received a medical intervention, and 116 patients (42.18%) were

Table 1. Demographics of patients and code blue status (*n*=275).

Variables	*N*	%
Gender		
Male	138	50.18
Female	137	49.82
Call block		
A	185	67.27
B	8	2.91
C	7	2.55
D	13	4.73
E	62	22.55
Call times according to shifts		
Day (08:00-16:00)	147	53.45
Night (16:01-07:59)	128	46.55
Call times on the shifts		
07:45-08:15/15:45-16:15	10	3.64
Other	265	96.36
Intervention		
Yes	199	72.36
No	76	27.64
Types of intervention		
Medical treatment	21	7.64
Only OTI	40	14.54
CPR and OTI	138	50.18
CPR		
Survival	68	49.28
Death	70	50.73
Referred units		
Emergency service	35	12.73
Intensive care unit	116	42.18
Death	70	25.45
Undelivered	54	19.64

OTI: orotracheal intubation; CPR: cardiopulmonary resuscitation.

admitted to the intensive care unit. The types of intervention were both orotracheal intubation (OTI) and CPR (50.18%; *n*=138), only OTI (14.54%; *n*=40), and medical treatment alone (7.64%; *n*=21). And one-fourth of the cases received no intervention (27.64%; *n*=76). A total of 68 patients with outcome survival had CPR duration time as 12.00 (6.00-12.00) min, and 70 patients with outcome death had duration as (40.03±10.08) min.

The departments receiving CB applications are shown in Table 2. CB calls occurred more frequently in Departments of General Surgery (17.09%; *n*=47), Internal Medicine (14.91%; *n*=41), Orthopaedics (8.36%; *n*=23) and Cardiology Clinics (7.64%; *n*=21). Approximately half of all cases (42.18%; *n*=116) were admitted the intensive care unit. No statistically significant difference was found between the duration of arrival and mortality ($P>0.05$; $Z=-1.304$).

Half of the CB calls were given due to cardiac arrest (50.18%; *n*=138), followed by respiratory failure/distress (8.72%; *n*=24), syncope (8%; *n*=22) and respiratory arrest (4%; *n*=11) (Figure 1). The causes of wrong CB calls were respectively pre-syncope (31.03%; *n*=9), out-of-purpose use (10.34%; *n*=3) and nausea-vomiting (6.99%; *n*=2), and no cause was reported in 9 cases (31.03%; *n*=9).

Other causes of wrong CB calls were psychiatric reasons (28.6%; *n*=2), cannula obstruction (14.28%; *n*=1), anaphylaxis (14.28%; *n*=1), drug allergy (14.28%; *n*=1), regurgitation (14.28%; *n*=1) and arrhythmia-bradycardia (14.28%; *n*=1). CB call took place more frequently at 10:00-12:00 am (17.45%; *n*=48); while wrong CB calls took place at 10:00-12:00 (37.03%; *n*=20), 8:00-10:00 (20.3%; *n*=11), 12:00-14:00 (14.8%; *n*=8), 16:00-18:00 (9.25%; *n*=5), 6:00-8:00 (7.4%; *n*=4), 14:00-16:00 (5.5%; *n*=3) (Figure 2).

Table 2. Departments receiving code blue applications (*n*=275).

Departments	*N*	%
General surgery	47	17.09
Neurology	9	3.27
Rheumatology	5	1.82
Cardiology	21	7.64
Gastroenterology	8	2.91
Hematology	4	1.45
Kidney transplantation-dialysis	12	4.36
Taking a blood sample	11	4.00
Orthopedics	23	8.36
Brain surgery	2	0.73
Internal medicine	41	14.91
Angioma	8	2.91
Polyclinic-kvc polyclinic	15	5.45
Radiological	13	4.73
Otorhinolaryngology	4	1.45
Urology-nephrology	9	3.28
Endoscopy	3	1.09
Women's birth	9	3.27
Effort-cardio	1	0.36
Laboratory	4	1.45
Pediatric surgery	1	0.36
Palliative	1	0.36
Infection	3	1.09
Dermatology	1	0.36
Coronary intensive care	1	0.36
Oncology	3	1.09
Nuclear medicine	1	0.36
Ophthalmology	1	0.36
Other units	14	5.09

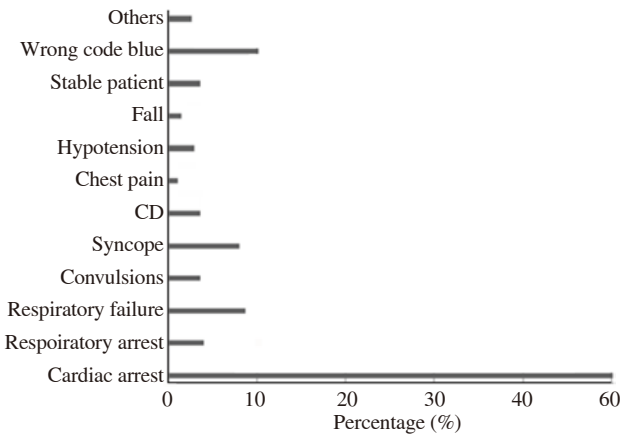

Figure 1. Reasons for code blue calls (*n*=275) (%). CD: consciousness disturbance.

The characteristics of patients who underwent the intervention of CPR are shown in Table 3. The most common diagnosis was acute renal failure-hypervolemia (16.7%; *n*=23). The first 24-hour survival rate was 39.1% (*n*=54), and the first 30-day survival rate was 18.1% (*n*=25). A total of 25 patients had operation. Besides,

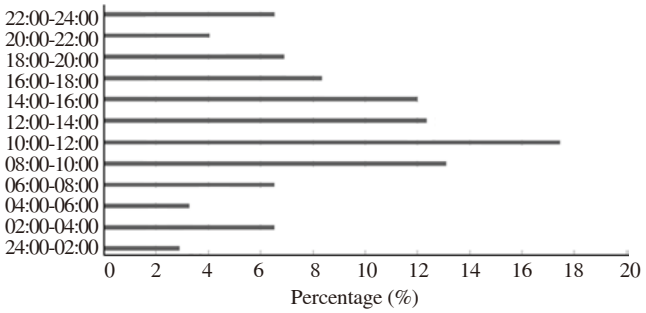

Figure 2. Time frame for code blue (n=275) (%).

Table 3. Characteristics of patients with CPR (n=138).

Characteristics	*N*	%
Admission diagnosis		
Myocardial infarction	10	7.2
Chronic heart failure	4	2.9
Cerebrovascular	5	3.6
Pneumonia	15	10.9
Cirrhosis of the liver	3	2.2
Malignancy	21	15.2
Acute kidney failure-hypervolemia	23	16.7
Gastrointestinal bleeding	4	2.9
Infection	13	9.4
Trauma	20	14.5
Other	20	14.5
Survival in the first 24 h		
Survival	54	39.1
Death	84	60.9
Survival in the first 30 d		
Survival	25	18.1
Death	113	81.9
Post-operation		
Post	25	18.1
Non-post	113	81.9
Comorbid diseases		
Hypertension	61	44.2
Diabetes mellitus	35	25.4
Coronary artery disease	27	19.6
Chronic obstructive pulmonary disease	18	13.0
Chronic heart failure	17	12.3
Chronic renal failure	22	15.9
Cerebrovascular	10	7.2
Parkinson	3	2.2
Alzheimer	9	6.5
Benign prostatic hyperplasia	10	7.2
Malignancy	14	10.1
Other	17	12.3

comorbid diseases included hypertension (44.2%; n=61), diabetes mellitus (25.4%; n=35) and coronary artery disease (19.6%; n=27). Five of the post-operation patients issued CB call again after 24 h from the intensive care exit.

No statistically significant difference was found between the duration of arrival and the first 24-hour survival rate (P>0.05; Z=-0.732). Similarly no statistically significant difference was found between the duration of arrival and the first 30 d survival rate (P>0.05; Z=-0.030).

It was observed that the mean arrival time from block A was significantly longer than that of block B and E. While the working hours and shift time showed no significant effect on the arrival time (Table 4).

Table 4. Arrival time (median (IQR))(min).

Variables	Arrival time	U/F	*P*-value
Code time on working hours			
07:45-08:15/15:45-16:15 (n=10)	2.06 (1.86-2.60)	-1.607	0.108
Other times (n=265)	2.26 (1.90-2.80)		
Blocks			
A (n=185)	2.36 (2.04-2.94)	23.88	0.001*
B (n=8)	1.96 (1.88-2.14)		
C (n=7)	2.22 (2.00-2.96)		
D (n=13)	2.18 (1.98-2.92)		
E (n=62)	2.01 (1.74-2.81)		
Average	2.14 (2.00-3.02)		
Code time according to shift			
Day (n=147)	2.25(1.90-3.05)	-0.138	0.890
Night (n=128)	2.30 (1.94-3.10		

*: P<0.05.

4. Discussion

The related literature showed that the rate of cardiac arrests within the hospital is 49.5%-69.9% in males, and 30.2%-50.5% in females[20-22]. Our study showed that the rates of CB occurred equally for both genders (male: 50.18%; female: 49.82%).

We found that the vast majority of CB applications took place in block A and in Department of General Surgery Clinics. Some studies reported that the CB applications were more frequently performed in the surgical intensive care unit, polyclinics, internal services and inpatient services[22,23]. The highest frequency of CB applications in the General Surgery Clinics is may be because that trauma and geriatric cancer surgery patients are usually treated in the General Surgery Clinics and the risk of developing cardiac arrest is high.

Unlike our study, some studies showed that CB applications were performed out of working hours (16:01-07:59)[5,8,22]. Besides, it was found that according to the working system, the time that the CB was issued is not effective on the mean duration of arrival to the scene.

According to the working hours, almost all CB applications (96.7%) were performed out of shift delivery times (07:45-08:15/15:45-16:15). It was found that working hours in which the code blue was given (07:45-08:15/15:45-16:15 and other hours) did not affect the average reach time. However, it was found that the highest number of CB calls and wrong CB activations were done between 10:00-12:00. Esen *et al.* reported the CB was given more frequently at 22:00-24:00, least at 16:00-18:00. Çiçekci and Atıcı reported that CB applications were performed predominantly at 6:00-7:00[5,24]. Some studies showed that the mean duration of arrival to the location where the CB was given varies between 0.67 and 8 min[5,8,22-24]. The median duration of arrival to the scene was 2.14 min in the present study and this value was shorter than the expected mean duration of arrival (3 min) before the onset of irreversible damage in the patients[23]. These results are favorable in terms of the quality standards of the hospital in which

the application is performed, patient safety and CB application process. However, it was seen that the 9.4% cases (n=26) had duration of arrival to the calls exceeded 3 min. This might be a result of the distance between the location of the CB team and the unit where the code is given.

The longest duration of arrival occurred in block A, the shortest one was determined to be in block B. On the upper floors of block B, there are intensive care units. Intensive care units do not give a CB call. Call units are on the lower floor of the block B and are easily accessible. Although the blue code team is located in block E on the 1st floor, it can be explained by the fact that the block B is reached in a shorter time, the structure of the block E is more complex and some parts are reached by elevator instead of stairs.

In addition, it was found that the mean duration of arrival to the CB calls given from block A was higher than that of block B and E. Although the distance between the blocks E and B is shorter than the distance between the blocks E and A, the longest duration of arrival to the scene is in block A. This could be explained by the fact that the distance between the blocks E and B is shorter than the distance between the blocks E and A, the number of floors in block A is higher than that of block B and the units in the block A are larger.

In the vast majority of CB applications, interventions were performed among 72.36% patients. As for the intervention methods, CPR was frequently performed after the OTI application, OTI was performed only in one-fifth of the cases, and medical treatment (mask, oxygen treatment, or medicine) was performed in 10% of all cases, Half of the cases were admitted to the intensive care unit. And these findings were supportive of the results of the past researches[22-24].

The rate of CB applications that do not require intervention varies between 5.8% and 48% and some research findings (27.6%) are compatible with these rates[22,23]. Applications that do not require intervention reduce the motivation of the staff and cause workforce losses.

While the mean CPR duration is 40.03 min for the patients with outcome as death, in line with our study, the research conducted in Turkey shows that the CPR application durations range from 27.5 to 35.2 min[5,24].

Half of the CB applications were given due to cardiac arrest, and other causes included respiratory failure/distress, syncope, and respiratory arrest. The causes of wrong CB applications were presyncope, out-of-purpose use, and nausea-and-vomiting; while 9 cases did not report causes. Esen *et al.* reported that approximately 80% of the CB applications were due to cardiac and/or pulmonary arrest. In addition, some studies reported that CB applications are mostly performed due to consciousness changes, hypotension, or causes apart from cardiac arrest[23,25].

The rate of wrong CB applications was 10.18%, and the rate of stable patients was 3.63%. And this finding was supportive of the previous research results which indicated that the rates of wrong CB application ranged from 6.7% to 9.9%[5,25]. It is thought that the lack of information, along with the lack of the use of risk assessment scales based on vital signs in the hospital might negatively affect the objective evaluation and might lead to wrong CB activations by creating a basis for human-oriented errors[17].

In the patients with cardiac arrest and CPR, the survival rate was 39.1% in the first 24 h and was 18.1% in the first 30 d. No statistically significant difference was found between the duration of arrival and mortality rates. Some studies also reported that the survival rates in the first 24 h ranged between 8.0% and 58.4%[5,19,23,24]. Besides, it was reported that 30-day long survival rates vary between 15%-20% in the United States, and this rate was 28% in Sweden[21]. In Turkey, it lacks of research directly investigating the 30-day long survival rates after cardiac arrest, and there is no national health care system that follows the long-term survival rates.

The results cannot be generalized since the study could not provide the comparison with other hospitals, and it was conducted in one hospital and in a single geographic field. This study provided the CB applications situation in a third level large-scale training and research hospital which provides health service in a metropolis. In addition, it also explores the influencing factors of the CB application process for the institutions and the hospitals where the study was conducted. Applications of CB should be analyzed at regular intervals as clinical quality indicators to decrease the arrival duration. In-hospital or national-based monitoring systems should also be established to follow the long-term survival rates and associated costs.

Conflict of interest statement

The authors report no conflict of interest.

Authors' contribution

Study design: M.S.S., N.S., G.S., and S.A.; Data collection and analysis: M.S.S., N.S., G.S., and S.A.; Manuscript writing: M.S.S., N.S., G.S., and S.A.; Contributed to the final version of the manuscript: M.S.S., N.S.; Supervised the project: M.S.S., N.S., S.A..

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