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ORIGINAL ARTICLE

Evaluation of cause-effect relationship and protocol compliance in code blue calls in a tertiary level hospital

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Abstract

Objective: Cardiopulmonary arrest (CPA) is a primary emergency that can be reversible and a code blue call is given for this. Our aim in this study is to evaluate the reasons and accuracy of the call-in patients and the intervention results who received a code blue call.

Methods: This study was retrospectively evaluated the blue code calls and applications given between 01.01.2019 – 01.06.2020 in a third-level hospital.

Results: Out of a total of 140 code blue calls, 33 (23.57%) were found to be incorrect. It was noted that code blue calls from outpatient clinics and imaging units often being incorrect ($p < 0.001$), made by doctors and nurses were more accurate ($p < 0.001$), and the accuracy of code blue calls was higher outside working hours ($p = 0.002$). Additionally, it was found that if spontaneous circulation could not be restored despite effective cardiopulmonary resuscitation (CPR) for 30 minutes, it was unlikely to be restored thereafter ($p = 0.001$).

Conclusion: This study strongly emphasizes the importance of accurate diagnosis, rapid intervention, and effective resuscitation in CPA cases. These results can reference measures to reduce incorrect code blue call rates, and improve patient outcomes in cardiac arrest situations.

Keywords: cardiopulmonary arrests; resuscitation; code blue

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Introduction

Cardiopulmonary arrest (CPA) is a primary medical emergency characterized by the disruption of cardiac and respiratory functions, and it is potentially reversible. Resuscitation refers to the collective efforts aimed at restoring the stopped cardiac and respiratory functions. When unresponsiveness is detected, resuscitation begins with chest compressions, followed by airway opening and rescue breathing. Simultaneously, assistance is summoned to mobilize additional resources [1, 2]. High-quality cardiopulmonary resuscitation (CPR) and early defibrillation for shockable arrhythmias remain the cornerstones of basic and advanced life support [1, 2].

In-hospital CPA is a significant public health issue in the United States, affecting approximately 300,000 adults annually and carrying a high mortality rate [3, 4]. Survival rates following in-hospital cardiac arrest improved until 2010 but have since plateaued, with approximately 25% of patients being discharged alive following intervention [5, 6]. The primary goal of CPR is to achieve the return of spontaneous circulation, while the long-term aim is to preserve the patient's prior health status and enable a functional life. To achieve these goals, specialized response teams for CPR have been established in hospitals.

The Emergency Color Code System is a comprehensive alert system designed to enable hospitals to respond promptly and effectively to situations requiring specialized intervention [7]. Universally recognized as the "Code Blue," this alert facilitates urgent medical intervention for patients requiring immediate care, ensuring all hospital personnel can respond quickly [8]. Through a standardized call system, the "Code Blue" ensures timely and precise intervention in cases of respiratory or cardiac arrest [8]. Response teams, organized for effective resuscitation, work in a multidisciplinary. Despite variations in terminology, these teams share a common global objective. In our country, these teams rapidly respond to the site of arrest through a designated group activated by the "Code Blue" announcement [9].

CPR continues to evolve through regularly updated algorithms, leading to improved accuracy in daily practice. An expanding body of literature suggests that integrating crisis resource management principles into medical care during resuscitation reduces chaos and enhances patient outcomes [10]. Unfortunately, studies evaluating CPR performance in both in-hospital and pre-hospital settings indicate that even trained healthcare providers often fail to meet basic life support guidelines [11, 12]. The primary objective of "Code Blue" implementation is to ensure that CPR is delivered swiftly and appropriately by experienced teams to patients in healthcare settings, 24/7 [9].

In this study, we aim to assess the "Code Blue" call system implemented in our hospital by examining its causes and outcomes. Our objective is to evaluate the accuracy of "Code Blue" calls, identify their underlying reasons, assess the effectiveness and adherence of interventions to established protocols, pinpoint deficiencies, and share the results of our investigation.

Material and methods

Our retrospective study, approved by the Local Human Clinical Studies Ethics Committee (Decision Number 2020/11-38, 14.09.2020), aimed to evaluate the Code Blue calls at Izmir Tepecik Training and Research Hospital between January 2019 and June 2020 in terms of cause-effect relationships and the effectiveness of interventions. All Code Blue calls, activated and recorded with the emergency code number 2222 from the internal phone number within the hospital, were examined retrospectively. Blue Code application forms included in the study were retrieved from archive records and scrutinized. The application forms were initially assessed for compliance with the Code Blue Regulation. Code Blue cases originating from intensive care units were excluded from the study because the calls did not adhere to the regulation. Subsequently, during the evaluation of the application forms, the calls were categorized as either correct or incorrect. A Code Blue call was considered correct if patients experienced CPA or if there was a prediction of imminent arrest.

In this study, the individual who witnessed the incident requiring or potentially requiring intervention, and initiated a Code Blue call or prompted others to call, was defined as a 'witness.' This category encompassed doctors, nurses, allied health personnel (technicians, medical secretaries), and other individuals (security personnel, cleaning personnel). The application forms were examined for patient demographic data, the time of the call, the time it took for the intervention team to reach the scene, the patient's level of consciousness, respiratory and cardiac status, interventions by the patient's primary physician and other healthcare professionals until the Code Blue team arrived, the initial cardiac rhythm, presence of CPA, whether chest compressions were applied during resuscitation, the duration of chest compressions, and the patient's final condition. In addition

to the information obtained from the application forms, details such as patients' known comorbidities, previous intensive care admission history, reason for hospital admission, presence of existing inotropic support, and follow-up status in patients with spontaneous circulation were gathered from the hospital database. Among the 211 Code Blue application forms collected, 12 were excluded due to insufficient information and failure to meet the inclusion criteria, while an additional 59 forms were excluded as they were initiated from intensive care units and did not adhere to the Code Blue Regulation.

Statistical Analysis

The SPSS version 26.0 program was used to analyze the data. Numbers and percentages are given for categorical variables, mean and standard deviation, and median are given for normal continuous variables. Data that did not show normal distribution were analyzed statistically using Mann-Whitney U, Kruskall Wallis and Chi-square test. In the study, $p<0.05$ was accepted as the level of statistical significance.

Results

In our study, we analyzed 140 Code Blue evaluation forms. It was observed that 107(76.40%) of these calls were correct, while 33(23.60%) were deemed incorrect. The most prevalent cause of inaccurate Code Blue calls was syncope (n:20, 60.60%). Upon examining the reasons for hospital admission of patients assigned a Code Blue, it was predominantly associated with cardiovascular system diseases. The average age of the patients was 63.00±18.63. Among the 140 patients considered correct calls, 83(59.28%) were male, and 57 (40.72%) were female. However, when comparing the reasons for hospital admission, age, and gender with the accuracy of Code Blue calls, no statistically significant relationships were found.

Table 1. Comparison of call accuracy with code blue variables.

		correct n (%)	incorrect n (%)
Call area	Inpatient services	75(92.59)	6(7.41)
	Policlinics	4(20.00)	16(80.00)
	Hemodialysis unites	11(91.67)	1(8.33)
	Coronary Angiography unite	15(88.24)	2(11.76)
	Imaging unites	2(20.00)	8(80.00)
Call time	Working hours	48(65.80)	25(34.20)
	Non-working hours	59(88.10)	8(11.90)
Witness	Doctor	40(87.00)	6(13.00)
	Nurse	50(87.70)	7(12.30)
	Care assistants	13(44.80)	16(55.20)
	Others	4(50.00)	4(50.00)

Table 2. Examination of the relationship between intervention result and CPR duration.

		Result of intervention				**p**
		Exitus		Spontaneous circulation		
		n	%	n	%	
CPR time	< 20 min	0	0.0	33	100.00	**0.001**
	20-30 min	3	30.00	7	70.00	
	> 30 min	35	100.0	0	0.00	

Table 3. The effect of the interventions performed before the code blue team on the results in patients who received CPR.

		Exitus after CPR n (%)	Spontaneous circulation after CPR n (%)	p
Cardiac compression	Applied	28 (73.7%)	36 (90.00%)	**0.033**
	Not applied	10 (26.3%)	4 (10.00%)	
Intubation status	Presence of intubation before the team	3 (7.90%)	6 (15.00%)	0.109
	Performed by the code blue team	35 (92.10%)	34 (85.00%)	

Analyzing the hours of the day during which correct Code Blue calls were made, 73 calls occurred during working hours, and 67 calls took place outside working hours. Comparing the time of Code Blue calls with correctness revealed that calls outside working hours were more correct (p=0.002). It was found that nurses were the personnel group most frequently initiating Code Blue calls, followed by doctors in second place, and it was observed that Code Blue calls made by doctors and nurses were highly correct (p<0.001).

Correct Code Blue calls were most frequently initiated from inpatient wards. The internal medicine ward had the highest frequency of Code Blue calls among all wards. Comparing the location of Code Blue calls with Code Blue correctness revealed that calls in outpatient clinics and imaging areas were more incorrect than those in other areas (p<0.001). The comparison of correctness with Code Blue variables is presented in Table 1.

When the code blue response team arrived at the scene, 74 patients were in cardiac arrest. Subsequently, cardiac arrest occurred in an additional 4 patients after the code blue team arrived on the scene. Of the total 140 patients, 62 required only respiratory support, and no CPR was performed. The average duration of CPR applied to these patients was found to be 6.00-37,50 (median-IQR) minutes. Unfortunately, all patients whose CPR lasted more than 30 minutes succumbed to the intervention. Among those intervened within 20-30 minutes, spontaneous circulation was achieved in 7 patients, while 3 did not survive. In the remaining 33 patients, the CPR duration was determined to be less than 20 minutes. It was observed that the rate of spontaneous circulation with CPR gradually decreased after the 20th minute, and this difference was found to be statistically significant in the analysis between the groups (Table 2).

Upon the arrival of the code blue intervention team at the scene, a total of 78 patients in cardiac arrest were assessed based on the initial cardiac rhythm detected. Asystole was identified in 58 (74.30%) patients, VF in 18 (23.10%) patients, and pulseless electrical abnormalities in 2 (2,60%) patients. Significant relationship was observed between the initial rhythm detected for establishing spontaneous circulation after CPR (p=0.018).

Among the 28 (20.00%) patients requiring respiratory support during code blue calls, two of them were intubated by the primary physician prior to the arrival of the intervention team. Of the 64 (45.71%) patients who underwent CPR, intubation was carried out in 9 patients by the primary physician before the intervention team arrived, including 2 patients who had been intubated previously. In cases of cardiac arrest, no significant difference was observed regarding the impact of early provision of respiratory support on the intervention outcome(p=0.109). However, it was noted that cases in which cardiac compression commenced before the intervention team's arrival were associated with achieving spontaneous circulation as a result of the intervention(p=0.033) (Table 3).

Discussion

CPA is an extremely urgent and critical situation that may be encountered not only by medical profession-

als but also by every individual at any given time. It is crucial for all of us to promptly recognize this situation and take immediate action. Regrettably, CPA is not always accurately detected within healthcare institutions, even by healthcare professionals, leading to challenges in providing the correct interventions. To address this concern, we conducted an analysis of the reasons behind code blue calls in our facility, a tertiary level training and research hospital, and evaluated the outcomes experienced by patients as a result of these interventions. Our study highlights the high rate of incorrect code blue calls, even in a tertiary hospital, and the high rate of patients remaining unattended until the code blue team arrives, at times when effective cardiopulmonary resuscitation is vital. Additionally, the findings of our study underscore the vital importance of early cardiac compression in CPA cases.

In our study, we examined 140 code blue calls, revealing an incorrect code blue call rate of 23.57%. The primary contributor to false code blue calls was identified as syncope. In a study by Cashman et al. [13], encompassing 878 emergency codes, a 6.71% rate of incorrect code calls was reported, with arrhythmia and syncope identified as the most prevalent causes. Kenward et al. [14], in their study reported a 30.07% rate of incorrect code calls, with "falling and vasovagal syncope" being the most common causes. Despite the already high false code blue call rates in our hospital, we believe the actual rates may be even higher, as many of these calls may not necessitate intervention by the code blue team, and the associated code forms may go unfilled. Consequently, we advocate for an increase in code blue training to mitigate false call rates. Indeed, a study demonstrated a reduction in incorrect code blue calls from 9% to 3.3% within a year following intensified code blue training [15].

In our study, it was seen that the most frequent calls were for inpatient wards. Among the inpatient wards, the locations with the highest frequency of code blue calls were internal medicine, general surgery, and infectious diseases wards, respectively. The observation that the internal medicine ward had the highest frequency of code blue calls aligns with existing literature on this matter [15, 16]. Additionally, another study reported that 29.2% of calls originated from the coronary intensive care unit [17]. However, code blue calls from outpatient clinics and imaging areas were statistically significantly more inaccurate compared to those from other areas. Given that syncope was the most common reason for false code blue calls in our study, we advocate for increased awareness among hospital personnel, especially those in densely populated areas within the hospital, regarding the appropriate circumstances for initiating a code blue call.

The time elapsed between the code blue call and the arrival of the response team is crucial for the effectiveness of early intervention in resuscitation. In our study cases of correct code blue calls, the response team took an average of 2.18±0.95 minutes to reach the scene. Petrie et al. [18]'s OPALS study demonstrated a 100% mortality rate in patients where the time to reach the call area exceeded 8 minutes. Another study revealed a success rate of 44.5% for patients reached within 3 minutes and commencing resuscitation, which decreased to 19.5% for arrival times exceeding 3 minutes [19]. In a study of 639 patients found that advanced life support was initiated within 4 minutes in 92% of cases [20]. However, they emphasized that, contrary to these results, this timeframe did not significantly impact the return of spontaneous circulation [20]. The duration may vary depending on hospital size and the availability of intervention teams. Despite our adherence to the procedure and an average arrival time of less than 3 minutes, some call areas exceeded the 3-minute threshold in our study. This can be attributed to the presence of independent blocks in our hospital and a single code blue team. We propose that, particularly in large hospitals, establishing additional emergency call response teams to cover different sections simultaneously would facilitate optimal response times for each code blue call.

In our study, an analysis of code blue call hours revealed a concentration of calls between 11-13 at noon. This may be due to the fact that the number of employees is low and the follow-up is less due to the fact that healthcare personnel take lunch breaks and a possible deterioration may not be noticed. When considering working hours, 67 (42.1%) code blue calls occurred during working hours, while 92 (57.9%) took place outside working hours. Consistent with similar studies in our country [21, 22], code blue calls were predominantly reported during non-working hours. When code blue call times and accuracy were compared, it was seen that code blue calls outside working hours were highly accurate (p=0.002). Consequently, our study advocates for the implementation of a 24/7 code blue system. In our hospital, the code blue radio phone is carried by the designated physician both during and outside working hours, ensuring swift response to incidents. Analysis of correct code blue calls highlighted that the majority originated from nurses and

doctors. A statistically significant relationship was observed when comparing the caller's profession and code blue accuracy ($p<0.001$). Doctors and nurses demonstrated higher accuracy in code blue calls. We propose that targeted training for personnel making inaccurate calls can mitigate false code announcements, reducing both time wastage and workload. We believe this will increase the motivation and efficiency of response teams. However, our study identified that in 14 cases of cardiac arrest, intervention commenced only upon the arrival of the code blue team. It is disheartening that despite the emphasis on universal basic life support and first aid training, no intervention was initiated by the ward staff until the code blue team arrived. We advocate for in-hospital training initiatives to equip all healthcare professionals with the necessary knowledge and skills for resuscitation and addressing.

In recent studies on basic life support applications, no significant difference in survival outcomes was observed when comparing the traditional approach of 30 cardiac compressions/2 rescue breaths with cardiac compression alone [23]. Initiating intubation for respiratory support by individuals lacking sufficient knowledge and skills may lead to delays in cardiac compression or interruptions, potentially resulting in unfavorable outcomes. Patients who received CPR before the code blue team reached the scene exhibited a lower mortality rate compared to those who did not initiate CPR. We contend that immediate initiation of chest compressions in patients experiencing deteriorating general conditions and cardiac arrest, facilitated through comprehensive courses and training for hospital personnel, could potentially elevate survival rates.

The duration of CPR following cardiac arrest is a critical factor impacting the likelihood of achieving spontaneous circulation. Nolan et al. [24] reported a survival rate of 45% for patients with CPR durations under 20 minutes, contrasting with an 18% survival rate for those exceeding 20 minutes. Similarly, Cicekci et al. [17] found that resuscitation rates were 40.3% for durations less than 20 minutes, 41.9% for 20-30 minutes, and 17.7% for durations surpassing 30 minutes, with successful spontaneous circulation restoration. Another study indicated spontaneous circulation restoration rates during CPR as 42% for durations under 15 minutes, 42% for 15-35 minutes, and 16% for durations exceeding 35 minutes [25]. In our study, 33 patients received CPR for less than 20 minutes, achieving spontaneous circulation. This subset constitutes 42.30% of patients receiving CPR, aligning closely with findings in the existing literature. The consistent correlation between CPR duration and successful outcomes underscores the importance of timely and efficient resuscitation efforts to improve overall survival rates in cardiac arrest cases.

Our study has several limitations that warrant consideration. Firstly, as a single-center study conducted in a tertiary-level hospital, the findings may not be fully generalizable to other healthcare settings, particularly those with different infrastructure, staffing levels, or patient populations. Secondly, the retrospective nature of the study relies on the accuracy and completeness of recorded data, which may introduce reporting bias. For instance, incomplete or unfilled code blue forms might have led to an underestimation of incorrect calls. Additionally, we were unable to evaluate the long-term outcomes of patients beyond the immediate success of cardiopulmonary resuscitation, limiting our ability to assess the broader impact of code blue interventions on survival and quality of life. Lastly, variations in the training, experience, and response times of healthcare personnel could not be fully standardized or accounted for, potentially influencing the observed outcomes. Future multicenter, prospective studies are needed to validate our findings and address these limitations comprehensively.

Conclusion

In summary, this study highlights the critical importance of precise diagnosis, prompt intervention, and effective resuscitation in CPA cases. We believe that this insight can serve as a reference for implementing measures aimed at enhancing the education and awareness of healthcare professionals, reducing the incidence of false code blue calls, and ultimately improving patient outcomes in the context of cardiac arrest situations.

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Conflict of interests

None.

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E.K., S.Ç.; Concept: E.K., E.A.; Design: : E.K., E.A.; Data Collection or Processing: E.K., S.Ç.; Analysis or Interpretation: E.K., H.O.S., M.G., E.A; Literature Search: E.K., H.O.S., M.G., Writing: E.K., H.O.S., M.G.,

Ethical Standards

All procedures were in accordance with the Declaration of Helsinki. Ethical approval was received from the Izmir Provıncıal Dırectorate Of Health, Health Scıences Unıversıty İzmir Tepecik Educatıon And Research Hospıtal, İzmir, Türkiye (2020-11-38).

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