

Clinical characteristics and outcomes of pediatric code blue activations in a tertiary care hospital: A retrospective cohort study

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ABSTRACT

Objective: The code blue system is an in-hospital early warning and emergency response mechanism designed to ensure rapid and effective intervention in critically deteriorating patients. This study aimed to evaluate the code blue activations implemented in our tertiary pediatric hospital.

Material and Methods: Demographic and clinical data of code blue events recorded between October 2019 and December 2020 at a tertiary pediatric hospital were retrospectively analyzed.

Results: The median age of patients was 146.0 months (IQR: 67.0–183.0), with 23 (39.0%) being male. Underlying chronic conditions were present in 27 patients (45.8%), most commonly neurological (n=9, 33.3%), followed by metabolic/genetic (n=6, 22.2%) and hematologic/oncologic disorders (n=6, 22.2%). Cardiopulmonary resuscitation (CPR) was performed in 10 patients, with a mean duration of 41.25±18.87 minutes (range: 25–60). The return of spontaneous circulation (ROSC) rate among those who received CPR was 90%. There were 4 in-hospital deaths (6.8%) following arrest. Comparison of admitted vs. non-admitted patients revealed that 13 (76.5%) of the admitted group were male (p<0.001), and their median age was significantly lower [67.0 (6.0–184.0) vs. 154.0 (99.5–184.0), p=0.013]. Among admitted patients, 10 (58.8%) were under 73 months of age, and 15 (88.2%) had chronic comorbidities (p<0.001). Code blue calls from pediatric wards resulted in hospital admission in 11 cases (84.6%), whereas 22 calls (52.4%) from phlebotomy units did not require admission (p<0.001).

Conclusion: The high frequency of sudden clinical deterioration among pediatric patients particularly in early childhood and those with chronic conditions emphasizes the critical need for timely and structured in-hospital emergency response. Strengthening code blue teams through early warning systems, continuous training, and structured protocols is essential for improving outcomes and reducing preventable adverse events.

Keywords: Code blue, cardiopulmonary resuscitation, mortality, rapid response team, pediatric, survival

INTRODUCTION

In-hospital cardiopulmonary arrest represents one of the most critical emergencies in pediatric medicine, requiring rapid, well-coordinated, and evidence-based intervention. Pediatric patients, due to their inherently limited physiological reserves and increased susceptibility to sudden clinical deterioration, are particularly vulnerable in such scenarios. Timely initiation of CPR and advanced life support by trained healthcare professionals has been consistently associated with improved survival rates and more favorable neurological outcomes in this population (1,2).

To optimize response in these life-threatening situations, many healthcare systems have implemented structured Code Blue protocols. Code Blue refers to a standardized in-hospital emergency response system that ensures the immediate mobilization of a multidisciplinary resuscitation team upon the recognition of cardiopulmonary arrest. While most commonly activated for cardiopulmonary arrest, in some institutions or under clinician judgment, critical events such as seizures or syncope may also prompt a Code Blue, depending on local protocols. The effectiveness of such systems hinges upon minimizing the time from arrest recognition to the initiation of life-saving interventions. In high-acuity environments such as tertiary referral hospitals, pediatric Code Blue systems are

particularly critical for standardizing care processes, reducing variability in response times, and enhancing overall patient safety (3,4).

Although Code Blue systems have become increasingly prevalent worldwide, the existing body of literature predominantly reflects data derived from adult populations in high-income countries. Pediatric-specific data remain limited, and contextual evidence from low and middle-income settings is especially scarce (5). Furthermore, the unique pathophysiology of pediatric arrest frequently secondary to progressive respiratory or circulatory failure necessitates dedicated evaluation of the timeliness and appropriateness of Code Blue responses in children.

In Türkiye, the Ministry of Health has formally mandated the establishment of Code Blue systems in all healthcare institutions, as outlined in regulations published in 2009 and 2011 (6,7). The national emergency activation line (2222) was designated to standardize call procedures, and institutional policies were developed to promote consistent implementation. However, despite these national efforts, real-world data regarding pediatric Code Blue activations, response characteristics, and clinical outcomes remain largely unexplored.

This study aimed to address this knowledge gap by retrospectively evaluating pediatric Code Blue activations at Ankara Bilkent City Hospital, one of the largest tertiary care centers in Türkiye. By examining cases reported between August 2019 and March 2021 in patients aged 1 month to 18 years, the study seeks to characterize the demographic and clinical profiles of the patients, analyze the response and resuscitation processes, and assess short-term clinical outcomes. The findings are expected to inform quality improvement initiatives and contribute to the optimization of in-hospital emergency response systems for pediatric populations.

MATERIALS and METHODS

Study Design and Setting

This study was designed as a retrospective, observational cohort analysis and conducted at Ankara Bilkent City Hospital, a high-capacity tertiary care institution serving as a major pediatric referral center in Türkiye. The study population comprised all pediatric patients aged between 1 month and 18 years for whom a Code Blue activation was initiated between August 2019 and March 2021.

Institutional Code Blue System

The Code Blue protocol at Ankara Bilkent City Hospital is governed by standardized institutional guidelines that clearly delineate the roles, responsibilities, and scope of practice of the emergency response team. Each team is composed of at least one physician and either an anesthesia technician or an emergency medical technician, and provides round-the-clock (24/7) coverage across all inpatient units, excluding emergency

departments, intensive care units (ICUs), and operating theatres, where Code Blue activation is not permitted under hospital policy.

Code Blue alerts are triggered via internal landline telephones by dialing “2222-5”, and the termination of the alert is carried out by dialing “2222-99” after the team arrives on-site and completes the required interventions. Upon activation, the resuscitation team is expected to reach the designated location within three minutes, carrying a fully equipped emergency intervention kit.

The scope of responsibility for Code Blue responders includes:

- immediate assessment of the patient’s clinical status,
- initiation of cardiopulmonary resuscitation (CPR),
- delivery of advanced life support (ALS) as indicated, and
- safe transfer of the patient to the appropriate level of care if stabilization is achieved.

All procedures and clinical interventions performed during Code Blue events are meticulously documented in the AD.FR.001 Code Blue Intervention Form, an institutional template for standardized data collection.

Operational tools, including DECT phones and access control cards, are rotated among team members between shifts to ensure seamless continuity. Daily inventory checks and handovers of emergency medications and supplies in the resuscitation kits are performed and recorded using the İY.FR.040 Emergency Medication and Supply Tracking and Handover Form. The anesthesia technician is responsible for maintaining appropriate stock levels, verifying expiration dates, and replenishing depleted materials in accordance with hospital protocols.

Data Collection

Data for the current study were retrospectively obtained from two primary sources:

1. The AD.FR.001 Code Blue Intervention Forms, completed contemporaneously by Code Blue responders; and
2. The institution’s electronic medical record (EMR) system, from which demographic data, clinical characteristics, resuscitation details, and patient outcomes were extracted.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics, version 29.0.2.0 (IBM Corp., Armonk, NY, USA). Frequency distributions were presented as numbers and percentages, and continuous variables were expressed as medians with interquartile ranges (IQR). The Kolmogorov–Smirnov test was used to assess the normality of data distribution.

For statistical evaluation, the Mann–Whitney U test was used for non-normally distributed data, and the Chi-square test was applied for categorical variables. For comparisons involving more than two groups, the Kruskal–Wallis test was used. A p-value of <0.05 was considered statistically significant.

RESULTS

During the study period, a total of 169202 visits to the pediatric emergency department and 169894 visits to pediatric outpatient clinics were recorded. A cohort of 59 pediatric patients with documented in-hospital code blue activations was retrospectively evaluated.

The median age of the patients was 146.0 months (interquartile range [IQR]: 67.0–183.0), and 23 (39.0%) were male. Nine patients (15.3%) were under the age of 25 months. An underlying chronic medical condition was present in 27 patients (45.8%), most commonly neurological disorders ($n=9$, 33.3%), followed by metabolic/genetic diseases ($n=6$, 22.2%) and hematologic/oncologic conditions ($n=6$, 22.2%) (Table I).

The majority of code blue activations ($n=49$, 83.1%) occurred during regular working hours (08:00–16:00). The most frequent locations of code blue events were the phlebotomy unit ($n=22$, 37.3%), pediatric inpatient wards ($n=13$, 22.0%), and hospital corridors ($n=10$, 16.9%). Syncope ($n=37$, 62.7%) was the leading cause of activation, followed by seizure activity ($n=9$, 15.3%) and respiratory arrest ($n=7$, 11.9%). The mean response time of the code blue team was 1.53 ± 0.6 minutes (range: 1.0–3.0) (Table II).

On-site emergency intervention was performed in 33 patients (55.9%), with intravenous access ($n=26$, 44.1%) and supplemental oxygen administration ($n=16$, 27.1%) being the most common procedures. A total of seven patients required resuscitative efforts in the pediatric intensive care unit (PICU), including three patients with respiratory arrest and 2 with cardiopulmonary arrest in the pediatric wards, and two patients who developed respiratory arrest during imaging procedures. All three patients with respiratory arrest on the ward achieved ROSC, although one subsequently died after one day in the PICU. Among the patients who experienced cardiopulmonary arrest, one failed to achieve ROSC despite resuscitative

Table I: Demographic characteristics of the patients

Age (months) [†]	146.0 (67.0–183.0)
1–24 [†]	9 (15.3)
25–72 [†]	6 (10.2)
73–132 [†]	12 (20.3)
133–216 [†]	32 (54.2)
Gender [†]	
Female	36 (61.0)
Male	23 (39.0)
Presence of underlying disease [†]	
Yes	27 (45.8)
No	32 (54.2)
Type of underlying disease [†]	
Neurological disease	9 (33.3)
Metabolic/genetic disease	6 (22.2)
Hematologic/oncologic disease	6 (22.2)
History of major surgery	5 (18.6)
Respiratory disease	1 (3.7)

*: median (IQR), †: n (%)

Table II: Characteristics of pediatric in-hospital code blue activations

Code Blue Activation Time*	
8:00 am to 4:00 pm	49 (83.1)
4:01 pm to 11:59 pm	5 (8.5)
12 midnight to 07:59 am	5 (8.5)
Location of Code Blue Activation*	
Blood Collection Unit	22 (37.3)
Inpatient Ward	13 (22.0)
Hospital Corridor	10 (16.9)
Radiology Department	7 (11.9)
Outpatient Department	7 (11.9)
Reason for Code Blue Activation*	
Syncope	37 (62.7)
Convulsion	9 (15.3)
Respiratory Arrest	7 (11.9)
Cardiopulmonary Arrest	3 (5.1)
Respiratory Distress	3 (5.1)
Response Time of the Code Blue Team [†]	1.53 ± 0.6 (1.0–3.0)
On-site Emergency Intervention*	
Yes	33 (55.9)
No	26 (44.1)

*: n (%), †: mean $\pm$ SD (min-max)

Table III: Management and outcomes of pediatric in-hospital code blue events

Location of Intervention*	
Pediatric emergency department	36 (61.0)
PICU	10 (16.9)
Pediatric ward	7 (11.9)
On-site	6 (10.2)
On-site Interventions [†]	
Intravenous access	26 (44.1)
Oxygen administration	16 (27.1)
Endotracheal intubation	10 (16.9)
Cardiopulmonary resuscitation	10 (16.9)
Drug administration	8 (13.6)
Bag-mask ventilation	5 (8.5)
Defibrillation	0 (0.0)
Outcome of cardiopulmonary resuscitation*	
ROSC	9 (90.0)
Death	1 (10.0)
Duration of Cardiopulmonary Resuscitation (minutes) [†]	41.25 ± 18.87 (25–60)
Hospitalization unit*	
Pediatric ward	9 (15.3)
PICU	8 (13.6)
Outcome*	
Discharged	55 (93.2)
Death	4 (6.8)
Observation in emergency department (hours) [§]	2.0 (2.0–4.0)
Length of inpatient stay (days) [§]	7.5 (4.0–5.8)
Length of PICU stay (days) [§]	4.0 (1.0–0.0)

*: n (%), †: Multiple interventions were performed in some patients, ‡: mean $\pm$ SD (min-max), §: median (IQR), **PICU**: Pediatric Intensive Care Unit, **ROSC**: Return of Spontaneous Circulation

Table IV: Comparison of hospitalized and non-hospitalized pediatric code blue cases

	Hospitalized	Non-Hospitalized	p
Gender*			<0.001 [‡]
Female	4 (23.5)	32 (76.2)	
Male	13 (76.5)	10 (23.8)	
Age (months) [†]	67.0 (6.0- 184.0)	154.0 (99.5- 184.0)	0.013 [§]
1- 24*	7 (41.2)	2 (4.8)	0.001 [‡]
25-72*	3 (17.6)	3 (7.1)	
73- 132*	0 (0.0)	12 (28.6)	
133- 216*	7 (41.2)	25 (59.5)	
Presence of underlying disease*			<0.001 [‡]
Yes	15 (88.2)	12 (28.6)	
No	2 (28.6)	30 (71.4)	
Location of code blue activation*			<0.001 [‡]
Blood collection unit	0 (0.0)	22 (52.4)	
Inpatient ward	11 (84.6)	2 (4.8)	
Hospital corridor	1 (5.9)	9 (21.4)	
Radiology department	5 (29.4)	2 (4.8)	
Outpatient department	0 (0.0)	7 (16.7)	
Reasons for issuing code blue*			<0.001 [‡]
Syncopal	3 (17.6)	34 (81.0)	
Convulsion	2 (11.8)	7 (16.7)	
Respiratory arrest	7 (41.2)	0 (0.0)	
Cardiopulmonary arrest	2 (11.8)	1 (2.4)	
Respiratory distress	3 (17.6)	0 (0.0)	

*: n(%), †: median (IQR), ‡: chi-squared test, §: Mann-Whitney U test

efforts on the ward. Ten patients underwent cardiopulmonary resuscitation (CPR), with a mean duration of 41.25±18.87 minutes (range: 25–60). The ROSC rate in this subgroup was 90%. Nine patients (15.3%) were admitted to pediatric inpatient wards and eight (13.6%) to the PICU. Four patients (6.8%) died following in-hospital arrest. Of the 36 patients who received initial intervention in the pediatric emergency department, 19 (52.8%) were discharged after observation. The median length of stay was 2.0 days (IQR: 2.0–4.0) for the pediatric emergency department, 7.5 days (IQR: 4.0–15.8) for pediatric wards, and 4.0 days (IQR: 1.0–10.0) for the PICU (Table III).

When hospitalization status was analyzed, male sex was significantly more prevalent among hospitalized patients (76.5% vs. 23.5%; $p < 0.001$). The median age was significantly lower in hospitalized patients [67.0 months (IQR: 6.0–184.0)] compared to those not admitted [154.0 months (IQR: 99.5–184.0); $p = 0.013$]. Furthermore, 41.2% of hospitalized patients were under 25 months of age, and 58.8% were under 73 months. A chronic underlying condition was present in 88.2% of hospitalized patients ($p < 0.001$) (Table IV).

The site of code blue activation was significantly associated with hospitalization status. Among patients with code blue activations originating from pediatric wards, 84.6% required admission, whereas 52.4% of those from the phlebotomy unit were not hospitalized ($p < 0.001$).

Analysis based on the cause of activation revealed that 81.0% of patients with syncope were discharged, while 41.2% of hospitalized patients presented with respiratory arrest (Table IV).

DISCUSSION

This study provides a comprehensive analysis of pediatric in-hospital code blue activations within a tertiary care institution, with a particular focus on patient demographics, underlying etiologies, temporal and spatial distribution patterns, implemented interventions, and subsequent clinical outcomes. The findings contribute valuable real-world data that support benchmarking against national and international standards, with potential implications for refining institutional patient safety strategies and emergency response protocols.

A key observation was the predominance of code blue activations during routine working hours (83.1%), predominantly occurring in procedural or high-traffic areas such as phlebotomy units and hospital corridors. This distribution is consistent with prior reports indicating temporal clustering of pediatric emergencies during peak operational periods, likely reflecting the heightened frequency of procedures and care transitions during these intervals (3,4,8).

Syncopal emerged as the leading cause of code blue activation (62.7%), with the majority of such cases being discharged from the emergency department. In contrast, respiratory arrest demonstrated a strong association with PICU admission, reinforcing the well-established role of respiratory compromise as a key determinant of clinical severity and poor outcomes in hospitalized children (2,5,9).

Furthermore, younger age, male sex, and the presence of chronic comorbidities were significantly associated with post-

activation hospital admission. Children with complex chronic conditions particularly neurological, genetic/metabolic, and hematologic/oncologic disorders were disproportionately represented among admitted cases. These findings are aligned with existing literature, which highlights the increased vulnerability of medically complex pediatric populations to acute clinical decompensation and the corresponding need for intensive monitoring and escalation of care (10–13).

Hospitalized patients had a significantly lower median age compared to non-admitted counterparts, supporting the notion that younger children, especially infants, possess limited physiological reserves and are more susceptible to rapid deterioration during acute events (14). Moreover, early clinical signs of decline in this age group may be subtle and easily overlooked by non-specialized personnel, underscoring the importance of standardized early warning tools such as the Pediatric Early Warning Score (PEWS) to support timely recognition and intervention (15,16).

The code blue team demonstrated a mean response time of 1.53 minutes, aligning with both national benchmarks and international best practice recommendations (1,9). Timely response remains a critical determinant of survival and neurological outcomes in pediatric resuscitation efforts. Notably, the ROSC was achieved in 90% of patients receiving CPR surpassing rates reported in several other series while the overall in-hospital mortality following arrest was 6.8%, in concordance with recent epidemiological data from North America and Europe (5,9,17).

A salient structural finding was the correlation between the location of activation and subsequent hospital admission. Code blue events occurring in inpatient wards were more frequently associated with hospital admission, likely reflecting the higher baseline acuity of these patients. In contrast, many activations in procedural areas such as phlebotomy units were transient and did not necessitate prolonged care. This spatial pattern underscores the potential value of implementing unit-specific training and early recognition protocols tailored to the clinical risk profile of different hospital zones (18).

While this study was conducted in a facility with an established code blue team, the broader integration of Pediatric Rapid Response Teams (PRRTs) and structured early escalation systems has been shown to significantly reduce the incidence of in-hospital cardiac arrest and improve early detection of clinical deterioration (19,20). The incorporation of such proactive and multidisciplinary response frameworks may further mitigate preventable arrests and contribute to the development of a robust and safety-oriented institutional culture.

This study has several limitations. Firstly, due to its retrospective design, the quality of the data relied heavily on the accuracy and completeness of existing medical records, and certain clinical details may have been missing or inconsistently documented. Additionally, as a single-center study, the generalizability of the

findings is limited; variations in hospital infrastructure and code blue protocols across institutions may influence outcomes. The assessment of code blue events may also have been affected by subjective reports or incomplete documentation from the responding personnel. Lastly, due to the lack of long-term follow-up data, it was not possible to evaluate the sustained impact of interventions. Therefore, future multicenter prospective studies are recommended to validate and expand upon these findings.

In conclusion, sudden clinical deterioration is frequently observed in pediatric patients, particularly among younger age groups and those with underlying chronic conditions, necessitating prompt and effective intervention. Timely and competent administration of CPR by the Code Blue team is crucial for improving survival outcomes and minimizing long-term morbidity. Therefore, ensuring that healthcare personnel receive regular, up-to-date training and comply with national safety standards set forth by the Ministry of Health is essential to enhance the overall quality and effectiveness of emergency response in pediatric care settings.

Ethics committee approval

This study was approved by the Ankara Bilkent City Hospital Clinical Research Ethics Committee (Decision No: E2-21-99; Approval Date: 10.02.2021).

Contribution of the authors

Study conception and design: **FK, DTK**; data collection: **DTK**; analysis and interpretation of results: **FK**; draft manuscript preparation: **FK**.

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Conflict of interest

The authors declare that there is no conflict of interest.

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