

ORIGINAL ARTICLE

Medicine Science 2023;12(4):1206-9

A comparison of code blue calls in a tertiary pediatric hospital in the pre-pandemic and pandemic periods

 SevdA Akdeniz,  Hatice Selcuk Kusderci,  Senay Canikli Adiguzel*Samsun University, Samsun Training and Research Hospital, Department of Anesthesiology and Reanimation, Samsun, Türkiye*

Received 25 August 2023; Accepted 02 September 2023

Available online 19.10.2023 with doi: 10.5455/medscience.2023.08.170

Content of this journal is licensed under a Creative Commons Attribution-NonCommercial-NonDerivatives 4.0 International License.



Abstract

This study compares the code blue calls (CBCs) used in our hospital before and during the COVID-19 pandemic. CBCs made between 31.03.2018 and 31.03.2022 in the Samsun Maternity and Child Health Training and Research Hospital were examined retrospectively. The study period was subdivided into two sections, one from March 31, 2018, to March 30, 2020 (Group 1, the pre-pandemic period) and the other from March 31, 2020, to March 31, 2022 (Group 2, the pandemic period). Patients' demographic data, the reason for the CBC and where it was issued, the time elapsed before the team arrived on the scene, and the outcomes were then compared between the groups. Seventy-nine CBCs, 34 (43.1%) of which were 'false', were included in the study. Forty-six calls were made in the pre-pandemic period, 26 (56.5%) of which were true calls, while 33 calls were made during the pandemic, of which 19 (57.6%) were true calls. Twenty-seven (60%) of the 45 true CBCs were for boys and 18 (40%) for girls. The children's mean age was 73.06 ± 66.85 months, and 57.7% of the CBCs were issued during the pre-pandemic period. No significant difference was observed between groups 1 and 2 in terms of code blue team arrival times (114.03 ± 59.14 vs. 138.1 ± 95.96 sec, respectively ($P=.305$)). The total mortality rate at the end of 30 days was 13.3% ($P=.679$). No difference was observed in CBC results between the pre-pandemic and pandemic periods in this study. We think that some blue code parameters, such as false calls and blue code team arrival times, can be improved through effective training against potential future pandemics.

Keywords: Coronavirus disease 2019, pediatrics, pandemic, code blue

Introduction

The coronavirus disease 2019 (COVID-19) pandemic affected all pediatric age groups. Children generally exhibit milder COVID-19 symptoms and have lower risks of hospitalization and life-threatening complications than adults. Although cardiac arrest associated with COVID-19 is rare in children, cases of severe disease or children developing a post-infectious multisystem inflammatory syndrome are not uncommon [1,2]. Children are therefore at risk of critical illness as a result of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Up to 30% of children hospitalized due to COVID-19 are admitted to intensive care units (ICUs) and as many as 5% to 15% require mechanical ventilation. Although these considerations applied throughout the pandemic, pediatric case numbers and

hospitalizations rose dramatically toward the end of 2021 [3]. The numbers of code blue calls (CBCs) for children may also have risen in line with that increase.

Code blue is a universal emergency system involving the reaction of a professional team in cases requiring emergency in-hospital intervention. The team is made up of a physician, an anesthesia technician, or a nurse with experience of cardiopulmonary resuscitation (CPR), and security staff. The system permits the prompt identification and management of emergencies requiring urgent medical attention, such as cardiopulmonary arrest. It reduces both mortality and morbidity in pediatric hospitals [4]. The application of the code system began in the USA. In Türkiye, it was initially implemented by the Ministry of Health in 2008 and was made compulsory in 2011 [5].

CITATION

Akdeniz S, Selcuk Kusderci H, Canikli Adiguzel S. A comparison of code blue calls in a tertiary pediatric hospital in the pre-pandemic and pandemic periods. Med Science. 2023;12(4):1206-9.



Corresponding Author: SevdA Akdeniz, Samsun University, Samsun Training and Research Hospital, Department of Anesthesiology and Reanimation, Samsun, Türkiye
Email: sevdA.akdeniz@saglik.gov.tr

Since CPR in patients with COVID-19 involves procedures that result in aerosolization, code blue algorithms have been developed for the protection of healthcare providers [6]. However, these algorithms also entail measures capable of causing delays in critical COVID-19 cases. This study compares the outcomes of CBCs made during the COVID-19 pandemic with those issued in the pre-pandemic period.

Material and Methods

The research was conducted among pediatric patients at the Samsun Maternity and Child Health Training and Research Hospital, Samsun, Türkiye, between 31.03.2018 and 31.03.2022. All CBCs made in our hospital are recorded on code blue report forms. CBCs issued during the study period were analyzed using these forms. The first positive case of COVID-19 in Türkiye was reported on March 11, 2020. This date was therefore adopted as the cut-off point between the two study groups. Group 1 (the pre-pandemic period) consisted of CBCs issued from March 31, 2018 to March 30, 2020, and Group 2 (the pandemic period) of those made from March 31, 2020 to March 31, 2022. The two groups were of equal duration in order to ensure the objectivity of the analysis.

Only CBCs from wards and clinics were included in the analysis. Calls involving individuals older than 18, those made from emergency rooms, operating rooms, and intensive care units where authorized cardiopulmonary resuscitation (CPR) providers were present, as well as calls from outpatient clinics, were excluded from the study. Clinical data including age, gender, COVID-19 status, the reason for the CBC, the time elapsed before the team arrived on the scene, endotracheal intubation status, cardiopulmonary resuscitation requirements, drugs used, survival in the first 24 hours, 30-day survival, discharge, and the status of the call (true – patients with cardiac or respiratory arrest, or false – patients without cardiac or pulmonary arrest) and outcomes were recorded and analyzed.

Statistical analysis

Data analysis was carried out on SPSS version 25 software (Statistical Package for Social Sciences- IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov test was applied to determine normality of measurable data. Descriptive statistics were expressed as mean±standard deviation for numerical variables and the significance of differences between the groups as evaluated using Student's t-test. Significance between categorical data was assessed using a chi-square test, numbers of cases and percentage values being. P values lower than .050 were interpreted as significant.

Results

Seventy-nine CBCs were issued during the study period, 45 (56.9%) of which were true calls. Forty-six calls were made in the pre-pandemic period, 26 (56.5%) of which were true calls, while 33 calls were made during the pandemic, of which 19 (57.6%) were true calls. Twenty-eight (60%) of the 45 true calls involved boys and 18 (40%) girls. The children's mean age was 73.06±66.85 months, and the mean time taken for the code blue team to reach the scene was 124.2±76.8 sec. The youngest

patient was nine days old, and the oldest 17 years old. Twenty-two (48.9%) CBCs were made between working hours (08.00–17.00). CBCs were most frequent in April 2018 in Group 1, with five calls being issued, and in June 2021 and February 2022 in Group 2, with three calls each.

Mean ages were 81.88±67.37 months in Group 1 and 61±65.99 months in Group 2 (P=.306). Mean times for the code blue team to reach the scene were 114.03±59.14 sec in Group 1 and 138.1±95.96 sec in Group 2 (P=.305). Boys outnumbered girls in both groups (53.8% in Group 1 and 68.4% in Group 2). No statistically significant differences were observed between the groups in terms of the place of origin of the call, CBC results, or times of calls.

The most common reason for CBC in Group 1 was epilepsy, presenting eight (30.8%) children, while the most common symptom in Group 2 was COVID-19, in six (31.6%). Postoperative pulmonary embolism was observed only one patient, from Group 1. Comparisons of code blue children's demographic and clinic data by groups are shown in Table 1.

Table 1. The children's demographic characteristics and other information

Variables	Total (n=45)	Group 1 (n=26)	Group 2 (n=19)	P*
Age (month, mean±SD)	73.06±66.85	81.88±67.37	61±65.99	.306
Girl gender (n, %)	18, 40%	12, 46.2%	6, 31.6%	.324
Reasons for CBC (n,%)				
Epilepsy	12, 26.7%	8, 30.8%	4, 21.1%	
Pneumonia	8, 17.8%	4, 15.4%	4, 21.1%	
COVID-19	6, 13.3%	-	6, 31.6%	
Respiratory fail	5, 11.1%	4, 15.4%	1, 5.3%	
Aspiration	5, 11.1%	3, 11.5%	2, 10.5%	.157
Heart failure	4, 8.9%	3, 11.5%	1, 5.3%	
Allergy	3, 6.7%	2, 7.7%	1, 5.3%	
Pulmonary emboli	1, 2.2%	1, 3.8%	-	
Premature	1, 2.2%	1, 3.8%	-	
Arrival time (sec, mean±SD)	124.2±76.8	114.03±59.14	138.1±95.96	.305
Call place (n, %)				
Ward	29, 64.4%	14, 53.8%	15, 78.9%	
Polyclinic	16, 35.6%	12, 46.2%	4, 21.1%	.082
Results (n, %)				
Intensive care	26, 57.8%	15, 57.7%	1, 5.3%	
Ward	9, 20%	5, 19.2%	4, 21.1%	
Emergency room	3, 6.7%	2, 7.7%	1, 5.3%	.990
Death	7, 15.6%	4, 15.4%	3, 15.8%	
Application hour (n, %)				
08:00-16:00	22, 48.9%	12, 46.2%	10, 52.6%	
16:00-24:00	14, 31.1%	8, 30.8%	6, 31.6%	.824
00:00-08:00	9, 20%	6, 23.1%	3, 15.8%	

* Chi-square or Student t-test.

CBC: code blue call, COVID-19: coronavirus disease 2019, SD: standart deviation

Types of treatment were similar between the groups. No difference was observed between the groups in terms of CPR application status, endotracheal intubation, use of adrenaline, or use of diazepam (P=.268, P=.463, P=.745, and P=.651, respectively). An evaluation of the intervention, which patients died within the first and 30th days, and which were discharged is shown in Table 2.

Table 2. Evaluation of the patients' intervention, discharge, and exitus status

Variables	Total (n=45)	Group 1 (n=26)	Group 2 (n=19)	P*
Fluid therapy (n, %)	42, 93.3%	24, 92.3%	18, 94.7%	.747
Airway (n, %)	28, 62.2%	15, 57.7%	13, 68.4%	.463
Cardiopulmonary resuscitation (n, %)	16, 35.6%	11, 42.3%	5, 26.3%	.268
Intravenous adrenaline (n, %)	17, 28.9%	12, 46.2%	5, 26.3%	.175
Intravenous atropine (n, %)	3, 6.7%	2, 7.7%	1, 5.3%	.747
Intravenous diazepam (n, %)	11, 24.4%	7, 26.9%	4, 21.1%	.651
Death within 24 hours (n, %)	4, 8.9%	2, 7.7%	2, 10.5%	.741
Death within 30 days (n, %)	6, 13.3%	3, 11.5%	3, 15.8%	.679
Discharge (n, %)	39, 86.7%	23, 88.5%	16, 84.5%	.679

*Chi-square test

Thirty-four false CBCs were made during the four-year study period. Eleven (32.3%) of these involved children experiencing hypotension when providing blood in the laboratory, seven (20.6%) with conversion disorder, four (11.8%) low blood pressure seen on the ward, three (8.8%) hypoglycemic attack, three (8.8%) involved CBC calls being made from different telephones but for the same patient, two (5.9%) resulted from hospital personnel giving an incorrect code, and two (5.9%) false calls by patients or relatives.

Discussion

The present study compared four-years CBC results in a tertiary pediatric hospital before and during the COVID-19 pandemic. Fewer CBCs were issued, patients were younger, CBCs were issued more from the wards, more frequently during normal working hours (08:00-16:00), and it took longer for the code blue team to reach the scene during the pandemic than before it. However, the differences between these values were not statistically significant.

The code blue system, a highly important measure in terms of reducing the risk of mortality in patients is mandatory in Türkiye. The fact that emergency intervention can be performed rapidly and by a dedicated professional team has a direct impact on the likelihood of survival. All guidelines involving the blue code system in the context of patients with COVID-19 have stressed the safety of the rescue team [3,6]. Many patients for whom critical care unit assess was needed during the pandemic had to be monitored on the wards, placing an extra burden on the rescue team. The use of protective equipment on the part of the team members inevitably led to unfortunate delays in the initiation of patient care [7].

Marked rises in pediatric case numbers and admission to hospital were observed toward the end of 2021, probably due to a combination of the new variant being highly transmissible and to mitigation measures being relaxed, resulting in a high community prevalence of SARS-CoV-2 in the pediatric age group [8]. In addition, incidental positive SARS-CoV-2 tests were observed in some children with no COVID-19 symptoms who experienced cardiac arrest [3]. Poorer cardiac arrest outcomes in adults have frequently been reported during the pandemic compared with the pre-pandemic period, with particularly poor arrest outcomes being observed in patients with COVID-19 [3]. However, data concerning cardiac arrest outcomes in children with the disease are limited [9]. Despite our low patient number, we nevertheless think that this study is particularly valuable as an evaluation of CBC outcomes during the pandemic in pediatric patients.

Although the difference was not statistically significant, fewer children were the subject of CBCs during the COVID-19 pandemic, and these were also younger. The low patient number may be attributable to patients presenting to emergency departments because of discontinuation of elective procedures and clinical services during the pandemic. Since experienced CPR staff are available in emergency departments, intensive care units, and operating rooms, these units cannot issue CBCs. Cardiac or pulmonary arrests occurring in these units were therefore not included in this study.

Time elapsing until the arrival of the response team where the blue code was activated was approximately 24 sec longer in the pandemic period than in the pre-pandemic period (average 114 sec vs. 138 sec, respectively), although the difference was not statistically significant. All resuscitation guidelines have stressed the essential nature of personal protective equipment in order to reduce the risk of exposure to contamination on the part of the reaction team. A delay of half a minute delay is regarded as being within normal limits. Adult studies with similar characteristics to those of the present research have reported a mean intervention time exceeding one minute during the pandemic period [10-12]. The present study is consistent with the previous literature from that perspective.

The numbers of CBCs in studies similar to our research but involving adults are quite high. Forty-five cases were enrolled in the present study. Adult studies have reported 135 cases over a nine-month period, 217 cases over a two-year period, and 748 in a one-year period. This may be regarded as normal in the light of the higher numbers of comorbid diseases in adults [10,11,13]. Due to the low numbers of CBCs in children, the number of studies on the subject is also very small. A previous sytudy from Türkiye reported 70 pediatric cases over 2.5 years. However, that study also included CBCs from the emergency department. When calls from the emergency department were excluded, the number of children decreased to 47 [5]. The number of cases in Chamberlain et al.'s pediatric study was 60 [14]. In terms of patient numbers, the present research is consistent with studies from Türkiye and from elsewhere.

Intravenous access was opened for 93.3% of the code blue team children to permit fluid or intravenous medical therapy. Airway

opening was achieved in 62.2% of children by means of a balloon valve mask with reservoir following airway insertion and with endotracheal intubation in 37.8%. Although the endotracheal intubation rate was higher in Group 1, this was not statistically significant. Similar studies involving children have reported endotracheal intubation rates of 22.4% and 35.7% [5,14]. The total exitus rate in this study at the end of 30 days was 13.3%. Rates of 6.9% and 8.5% have been reported in similar studies [5,14]. Our research is thus consistent with previous studies from that perspective.

Almost half the CBCs in both groups in this study were issued out of normal working hours. Code blue is a 24-hour service covering the whole hospital. We therefore think that the hospital management should continually raise awareness of the code blue team and prioritize in-service training sessions.

The mean time to the arrival on the scene of the blue code team in this study was 124 sec. Times between 2.02 and 3.4 min have been reported in studies of children and research similar to our own [5,14]. Adult studies have reported times of 2.8, 2.3, and 2.0 min [10,12]. Similar times for arrival of the blue code team to that in the present research have been reported in studies from both Türkiye and other countries. The initiation of basic and advanced life support in cardiovascular arrest yields better clinical outcomes, and the patient should be treated as early as possible [15]. The blue code system therefore appears to be applied within the target time and in a successful manner in our hospital.

Thirty-four (43.1%) calls in our hospital were false. Another pediatric study reported a figure of 57.2% [5]. This may be due to cardiopulmonary arrest not always being easy to identify, incorrect decisions resulting from those issuing the call having to make rapid decisions, human error deriving from distraction or fatigue, technical errors, or curiosity on the part of patients pressing the relevant numbers. We think that the false CBC rate can be reduced and the blue code system function more accurately and effectively by means of regular and continuous in-house training sessions for all hospital personnel.

There are a number of limitations to this study. The first involves its retrospective and single-center nature. Although a four-year period was reviewed, our patient number is low. Since the incidence of arrest is higher in adults, and ours is a pediatric hospital, the number of pediatric CBCs is also lower than in adults. In addition, CBCs from intensive care units were not included in this study, and mortality was therefore not investigated. Moreover, initial heart rhythm, initial respiratory rhythm, and CPR time could not be reported due to deficient data. Despite these limitations, however, we think that this research is valuable as one of the rare studies of CBC outcomes in children.

Conclusion

In conclusion, arrival at the location where the blue code was activated was delayed by approximately 30 sec. The COVID 19 pandemic also made the routine resuscitation procedure particularly problematic. Proper donning of protective equipment in order to minimize the risk of contamination and initiating the

intervention without delay are both of major importance for the reaction team in critical COVID-19 patients for whom blue codes have been issued. Another pandemic resembling COVID-19 may again arise in the future. Our primary objective for successful resuscitation should therefore be to develop strategies for minimizing the time between proper donning of protective equipment and responding to the blue code.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that they have received no financial support for the study.

Ethical Approval

This study was approved by the Samsun University Clinical Researches Ethics Committee (Ref No. 2023-3/2, Date: 09.02.2023).

References

1. Cui X, Zhao Z, Zhang T, et al. A systematic review and meta-analysis of children with coronavirus disease 2019 (COVID-19). *J Med Virol*. 2021;93:1057-69.
2. Nikolopoulou GB, Maltezou HC. COVID-19 in Children: Where do we Stand?. *Arch Med Res*. 2022;53:1-8.
3. Morgan RW, Atkins DL, Hsu A, et al. Guidance for cardiopulmonary resuscitation of children with suspected or confirmed COVID-19. *pediatrics*. 2022;150:e2021056043.
4. Sahin KE, Ozdinc OZ, Yoldas S, et al. Code blue evaluation in children's hospital. *World J Emerg Med*. 2016;7:208-12.
5. Sik G, Citak A. Evaluation of code blue implementation and its outcomes in pediatric patients. *JARSS*. 2020;28:47-51.
6. Turkish Ministry of Health Guideline for the Diagnosis and Treatment Protocol for COVID-19. <https://covid19.saglik.gov.tr/> access date 01.07.2023.
7. Chan PS, Berg RA, Nadkarni VM. Code blue during the COVID-19 pandemic. *Circ Cardiovasc Qual Outcomes*. 2020;13:e006779.
8. Marks KJ, Whitaker M, Anglin O, et al. COVID-NET surveillance team. hospitalizations of children and adolescents with laboratory-confirmed COVID-19—COVID-NET, 14 States, July 2021–January 2022. *MMWR Morb Mortal Wkly Rep*. 2022;71:271-8.
9. Lauridsen KG, Morgan RW, et al. PediRES-Q Investigators. In-hospital cardiac arrest characteristics, CPR quality, and outcomes in children with COVID-19. *Resuscitation*. 2021;169:39-40.
10. Delen LA, Disli ZK. Evaluation of code blue activations in COVID 19 patients and non-COVID-19 patients: a retrospective research review. *Medi Science*. 2022;11:195-8.
11. Arslan K, Şahin AS. Evaluation of code blue calls in the pre-pandemic and pandemic period: a tertiary care hospital experience. *IKSSTD*. 2022;14:214-20.
12. Tong SK, Ling L, Zhang JZ, et al. Effect of the COVID-19 pandemic on cardiac arrest resuscitation practices and outcomes in non-COVID-19 patients. *J Intensive Care*. 2021;9:55.
13. Özçelik S, Uzuner LA. Analysis of “code blue” application and results: a single center experience. *Anatolian Curr Med J*. 2022;4:34-8.
14. Chamberlain G, Gupta R, Lobos AT. Pediatric code blue event analysis: Performance of non-acute health-care providers. *Med Educ Online*. 2022;27:2106811
15. Welbourn C, Efsthathiou N. How does the length of cardiopulmonary resuscitation affect brain damage in patients surviving cardiac arrest? A systematic review. *Scand J Trauma Resusc Emerg Med*. 2018;26:77.