Comparison of in-Hospital Cardiopulmonary Resuscitation Results Before and After the Introduction Code Blue

Mavi Kod Öncesi ve Sonrası Hastane İçi Kardiyopulmoner Resüsitasyon Sonuçlarının Karşılaştırılması

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ABSTRACT Objective: Early intervention improves survival rates after cardiopulmonary arrest (CPA). The efforts of early interventions aimed at enhancing the code blue of practice have also led to the rapid settlement in our country. The aim of this study was to compare the results of cardiopulmonary resuscitation (CPR) before and after the code blue applications were introduced in our hospital. **Material and Methods:** The study was carried out retrospectively by examining case data and patients' files for a period of approximately four years before and after the introduction of Code Blue in Konya Numune State Hospital. The time of CPA, arrival time of CPAs, total time of CPR occurrence and CPR time period (<20 min, 20-30 min, and >30 min), initial rhythms at the start of CPA, a return of spontaneous circulation (ROSC), cases surviving within first 24 hour and cases after hospital discharge, and according to the initial and the CPR time period, ROSC, 24-hour survival and hospital discharge were compared. **Results:** The time to the arrival of the patient undergoing CPA was found to be decreased ($p<0.001$), the time to the application was increased ($p<0.001$). The number of ventricular fibrillation/pulseless ventricular tachycardia monitored the initial rhythms was also increased ($p<0.001$). As well as an increase in CPRs, the ROSC and the rates of survival and the discharge were increased according to the initial rhythm and the CPR application time ($p<0.001$) with the advent of the code blue. **Conclusion:** We believe that after the introduction Code Blue in our hospital, the results of success in hospital CPR have increased.

Key Words: Cardiopulmonary resuscitation; heart arrest; hospital mortality; survival rate; patient discharge

ÖZET Amaç: Kardiyopulmoner arrest (KPA) sonrası erken müdahale sağkalım oranlarını arttırmaktadır. Erken müdahaleyi arttırmaya yönelik çabalar mavi kod uygulamalarının ülkemizde de hızla yerleşmesine neden olmuştur. Çalışmanın amacı, Hastanemizde mavi kod uygulaması başlaması öncesi ve sonrası kardiyopulmoner resüsitasyon sonuçlarını karşılaştırmaktır. **Gereç ve Yöntemler:** Bu çalışma, Konya Numune Hastanesi'nde Mavi Kod başlaması öncesi (Grup I) ve sonrası (Grup II) yaklaşık 4 yıllık süredeki hasta dosyaları ve kardiyopulmoner resüsitasyon (KPR) formlarını geriye dönük inceleyerek yapıldı. KPA meydana gelme zamanı (hafta içi mesai, hafta içi mesai sonrası, hafta sonu) KPA'ya ulaşma süresi, toplam KPR uygulama süresi, KPR'deki ilk ritim, KPR uygulama zaman dilimi (<20dk, 20-30dk ve >30dk), spontan dolaşımın geri dönmesi (SDGD), ilk 24 saatte hayatta kalma ve taburculuk oranları, ayrıca KPR'deki ilk ritme (asistoli, ventriküler fibrilasyon/ ventriküler taşikardi) ve KPR uygulama zaman dilimine göre SDGD, hayatta kalma ve taburculuk karşılaştırıldı. **Bulgular:** Mavi kod uygulamasının başlaması ile KPA geçiren hastaya ulaşma süresi kısaldı ($p<0,001$), KPR uygulama süresi arttı ($p<0,001$), monitorize edilen ilk ritim olan ventriküler fibrilasyon/nabızsız ventriküler taşikardi sayısı arttı ($p<0,001$), ilk ritme ve KPR uygulama zaman dilimine göre SDGD, ilk 24 saatte hayatta kalma ve taburculuk oranlarının arttığı saptandı ($p<0,001$). **Sonuç:** Hastanemizde mavi kod uygulaması başladıktan sonra hastane içi kardiyopulmoner resüsitasyon sonuçlarındaki başarının arttığı kanaatindeyiz.

Anahtar Kelimeler: Kardiyopulmoner resusitasyon; kalp durması; hastanede ölüm oranı; sağkalım oranı; hastanın taburcu olması

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Although half a century has passed since the first definition and application of cardiopulmonary resuscitation (CPR), mortality rates are still higher compared to those of cardiopulmonary arrest (CPA) (approximately 85%).[1,2] There are various potential factors that affect these high rates, such as geography, changes in the success of CPR throughout the years, hospital and intensive care characteristics, working hours and shift rotations at the hospital.[3-9] Code blue teams (CBTs) are used in various countries around the world. Such teams are composed of specialized and skilled clinicians who respond to the patient in CPA in the shortest possible time to minimize the negative effects of these of CPR and decrease CPA mortality and morbidity rates.

In our hospital, the CBT is composed of an anaesthesiologist, an anaesthesia technician and a security guard. Upon receiving an incoming call, the CBT reaches the arrest unit in 3 min at the latest. The healthcare personnel of the unit maintain basic life support until the CBT arrives. When the CBT reaches the unit from which the call was received, the anaesthesiologist obtains information about the patient from the doctor or the nurse overseeing the patient, takes over the leadership from the rest of the team and starts, continues and ends CPR when appropriate.

No study has evaluated the results of CPR since the start of the use of CBTs in Turkey (first introduced in 2008). For this reason, we aimed to compare the results of CPR before and after the code blue call system was introduced in our hospital.

While the cases of arrests were intervened by the doctors, nurses and anesthesiologists responsible for the department where arrests occurred before code blue call system was installed, the cases were started to be intervened by the code blue team after code blue system had been installed.

MATERIAL AND METHODS

The study was conducted with the approval of Necmettin Erbakan University Faculty of Medicine ethics committee (Ref. no. 2013/359). The study was carried out retrospectively by examining case data and patients' files for a period of approximately four years (between May/2009 and May/2013) starting two years before the introduction of CBT in Konya Numune Hospital and ending two years later. Of the cases on which CPR was performed, 411 cases before the code blue was introduced (Group 1) and 390 cases after the code was introduced (Group 2) were included in the study. Code blue calls were received from other departments of the hospital, such as surgical and nonsurgical services, polyclinics, social areas within the hospital, laboratories and dialysis units. False code blue calls that did not require resuscitation, CPAs that arrived in our emergency unit from outside and patients under the age of 18 years due to the lack of paediatric ward were excluded from the study.

Those who performed the resuscitation in our hospital before or after the code blue was introduced were selected from personnel who were trained in accordance with the current advanced life support protocols [2005 and 2010 European Resuscitation Council (ERC) Guidelines].[10,11] Demographic data such as the age and gender of the cases were recorded.

The CPA occurrence time was grouped as weekday working hours (Monday, Tuesday, Wednesday, Thursday and Friday between 08.00^{00}-16.00^{00} h), after working hours (between 16.00^{00}-08.00^{00} h) and also weekends (between Friday 16.00^{00}-Monday 08.00^{00} h). Official holidays and festivals were included in the weekend group.

The time to the arrival of the CBT, the total CPR occurrence time and the CPR time period (less than 20 min, between 20 and 30 min, and more than 30 min) were recorded in minutes.

The initial rhythms at the start of the CPA were recorded as asystole/pulseless electrical activity (PEA), ventricular fibrillation/pulseless ventricular tachycardia (VF/pVT) and unknown rhythms (patients without a record at the initial rhythm section at the time of arrest).

Successful cases as a result of resuscitation were defined as cases with a return of spontaneous

circulation (ROSC), cases that survived in the first 24 h and cases that could be discharged from hospital.

Furthermore, the ROSC and the 24 hour survival and the hospital discharge rates were recorded according to the initial rhythm and the CPR time period.

STATISTICAL ANALYSIS

The data were loaded on SPSS 21.0 software and evaluated as the mean±standard deviation (SD) and percentage. Descriptive statistics and the frequencies of categorical variables were presented as tables. Numerical variables were then applied to the descriptive measures. Kolmogorov-Smirnov and Shapiro-Wilk normality analyses were performed for the group variables. Comparisons between two groups were made with the Student's *t* test for parameters with a normal distribution. The Mann-Whitney *U* test was used for parameters without normal distribution. The Kruskal-Wallis test was used for parameters with more than two variables. The comparison of categorical variables was performed with a Chi-Square test (kxc contingency tables) and Cramer's V correlation coefficient. The level of significance was taken as 0.05.

RESULTS

PATIENT CHARACTERISTICS

The results of 801 patients before and after the introduction code blue were evaluated. Patient and event characteristics were indicated in Table 1.

EVENT CHARACTERISTICS

When the groups were evaluated in terms of the CPA time, the rates were 32.6% and 29.2% during working hours, 40.9% and 40.7% after working hours on week days; and 26.5% and 30.1% for weekends in Groups 1 and 2, respectively, (p>0.05).

The CPA arrival time was 2.4±0.9 min (95% confidence interval CI 2.3-2.5) for Group 1 and 1.7±0.6 min (95% CI 1.69-1.81) for Group 2. The decrease observed in Group 2 was statistically significant (p<0.001).

The CPR application time was 22.8±7.7 min. (95% CI 22.09-23.6) for Group 1 and 25.5±11 min. (95% CI 24.35-26.55) for Group 2. The increase observed in Group 2 was found to be statistically significant (p<0.001).

The CPR time period (<20 min, 20-30 min, >30 min) was 45.7%, 39.7% and 14.6%, respectively, for Group 1, and 39.5%, 35.1% and 25.4%, respectively, for Group 2. The difference between two groups was statistically significant (p<0.001).

The initial rhythm (asystole/pulseless electrical activity, ventricular fibrillation/pulseless ventricular tachycardia and unknown) was 59.1%, 29.1% and 11.6%, respectively, for Group 1, and 26.6%, 68.4% and 4.8%, respectively for Group 2. The difference between the two groups was statistically significant (p<0.001).

The ROSC, and the 24 hour survival and the hospital discharge rates were 19.2% and 34.6% (p<0.001), 13.6% and 26.4% (p<0.001) and 4.6% and 11.2% (p<0.001) for Groups 1 and 2, respectively. There was a significant difference between the groups in terms of the ROSC, and the 24 hour survival and the hospital discharge rates (Table 1).

THE INITIAL RHYTHM DATA FOR THE ROSC, AND THE 24 HOUR SURVIVAL AND THE HOSPITAL DISCHARGE RATES

The comparison of the initial rhythm data of the groups in terms of the ROSC, and the 24 hour survival and the hospital discharge rates showed that the ROSC asystole/PEA rates for Groups 1 and 2 were 54.8% and 45.2%, respectively. The VF/pVT rates were 26.8% and 73.2, and the unknown rhythm rates were 0% and 100%, respectively for both groups (p<0.001). The 24 hour survival rates were as 55% and 45% according to the asystole/PEA in Groups 1 and 2; as 24.2% and 75.8% according to the VF/pVT rates in Groups 1 and 2; and as 0% and 100% according to unknown rhythm rates in Group 1 and Group 2, respectively (p<0.001). The hospital discharge asystole/PEA rates were 52.9% and 47.1%; the VF/pVT rates were 22.2% and 77.8%; and, the unknown rhythm

TABLE 1: Patient and event characteristics.

	Grup 1 (Before CB) (N=411) Mean±SD, or %	Grup 2 (After CB) (N=390) Mean ± SD, or %	χ^2	Cramer's V	p
Age, years	71±15,4	72,2±13,9	5.363	0.036	0.68
Sex			827	0.032	0.39
Male	54,5	57,7			
Female	45,5	42,3			
CPA occurrence time			3.310	0.064	0.191
Weekday working days[a]	32.6	29.2			
Weekday evening/night[b]	40,9	40.7			
Weekend[c]	26.5	30.1			
CPA arrival time (min)	2,4±0.9	1,7±0,6	17.867	0.164	< 0.001
Total CPR time (min)	22,8±7,7	25,5±11	14.023	0.129	< 0.001
CPR time period (min)			14.659	0.135	<0.001
<20[d]	45.7	39.5			
20-30	39.7	35.1			
>30[e]	14.6	25.4			
CPR initial rhythm			123.604	0.393	<0.001
Asistole/PEA	59.1	26.6			
VF/PVT	29.1	68.4			
Unknown[f]	11,6	4.8			
ROSC			24.221	0.174	< 0.001
Yes	19,2	34.6			
No	80,8	65.4			
24 hour survival			20.559	0.160	<0.001Z
Yes	13,6	26.4			
No	86,4	73.6			
Hospital discharge			12.246	0.124	<0.001
Yes	4,6	11.2			
No	95,4	88.8			

CPA: Cardiopulmonary arrest; PEA: Pulseless electrical activity; VF: Ventricular fibrillation; PVT: Pulseless ventricular tachycardia; χ^2, Chi-Square; ROSC: Return of spontaneous circulation.

[a]Monday, Tuesday, Wednesday, Thursday and Friday between 08.00-16.00 h; [b]After working hours, between 16.00-08.00 h; [c]Weekends, between Friday 16.00-Monday 08.00 h; [d]Less than 20 min; [e]More than 30 min; [f]Patients without a record at the initial rhythm section at the time of arrest.

rates were 0% and 100% in Groups 1 and 2, respectively (p<0.001). There was a significant difference in terms of the ROSC, and the 24 hour survival and the hospital discharge rates for the cases with an initial rhythm of VF/pVT (Table 2).

THE CPR TIME PERIOD FOR THE ROSC, AND THE 24 HOUR SURVIVAL AND HOSPITAL DISCHARGE RATES

The comparison of the two groups in terms of the CPR time period for the ROSC, and the 24 hour survival and hospital discharge rates showed that for ROSC, the 0-20 min rates were 34.5% and 65.5%; the 20-30 min rates were 35.4% and 64.6%; and, the >30 min rates were 50% and 50% in Group 1 and Group 2 (p=0.275). As to 24 hour survival rates, the 0-20 min rates were 30.9% and 69.1%; the 20-30 min rates were 34.7% and 65.3%; and, the >30 min rates were 48.3% and 51.7% in Group 1 and Group 2 (p=0.241). For the discharge, the 0-20 min rates were 20% and 80%; the 20-30 min rates were 41.2% and 58.8%; and, the >30 min rates were 45.5% and 54.5% in Groups 1 and 2 (p=0.141). When the groups were compared, although an increase was observed in the ROSC, and the 24 hour

TABLE 2: The ROSC, and the 24 hour survival and hospital discharge rates according to the initial rhytm.

	Group 1 (Before Code Blue) No (%)			Group 2 (After Code Blue) No (%)					
	Asystole/PEA	VF/pVT	Unknown	Asystole/PEA	VF/pVT	Unknown	χ^2	Cramer's V	p
ROSC	46 (54.8)	33 (26.8)	0 (0)	38 (45.2)	90 (73.2)	7 (100)	20.957	0.313	<0.001
24 hour survival	33 (5.5)	23 (24.2)	0 (0)	27 (45)	72 (75.8)	4 (100)	17.511	0.332	<0.001
Hospital discharge	9 (52.9)	10 (22.2)	0 (0)	8 (47.1)	35 (77.8)	1 (100)	5.843	0.308	<0.001

PEA: Pulseless electrical activity; VF: Ventricular fibrillation; pVT: Pulseless ventricular tachycardia; χ^2: Chi-Square; ROSC: Return of spontaneous circulation.

survival and hospital discharge rates of the cases with a CPR time period of 0-20 min, this increase was not statistically significant. The differences in the ROSC, and the 24 hour survival rates of the cases in the 20-30 min and the >30 min periods between the groups were also not statistically significant (Table 3).

DISCUSSION

The comparisons of male/female rates of in-hospital arrests before and after the introduction code blue have shown that rates in males vary between 56 and 69.9%, whereas those in females vary between 30.2 and 43.1%.[12-15] The lower arrest rates in females might result from the fact that coronary problems, such as myocardial infarction and angina pectoris are less frequently observed among females.[15,16] In this study, the male/female rate and the mean age of the patients were compatible with the literature.[12,17-20]

Occurrence rates of CPA during the day and at night vary in several studies. Arrest rates at night varied between 53 and 64%, arrest rates during the day varied between 26 and 46% and arrest rates at weekends varied between 26 and 28%.[9,14,17,21] The rates found in this study for weekdays during the day, weekday nights and weekends are compatible with the related literature.

Studies have confirmed that the early arrival of the CPR team to patient in arrest and the early start of defibrillation increase the chance of life and hospital discharge rates.[12,13,15,16] In the guidelines accepted by The American Heart Association in 2000, teams should respond to a cardiac arrest and administer the first electrical shock in less than 2 min.[9,14,16] According to the CPR committee of The Broke Amy Medical Center, the CPR unit should reach the patient in arrest in less than 3 min and start treatment in less than 10 min.[12,16]

One study showed that starting CPR in 1.5-3 min was more successful than starting the procedure more than 5 min after the arrest.[22] In several studies, the mean CPR starting time varied between 80 sec (1.3 min) and 341 sec (5.7 min).[23-25] In this study, the time for the arrival of the CBT to the arrest and the start of the CPR before and after the introduction of code blue was similar to the

TABLE 3: The ROSC and the 24 hour survival and hospital discharge rates according to the CPR time period.

	Group 1 (Before Code Blue) No (%)			Group 2 (After Code Blue) No (%)					
	Asystole/PEA	VF/pVT	Unknown	Asystole/PEA	VF/pVT	Unknown	χ^2	Cramer's V	p
ROSC	46 (54.8)	33 (26.8)	0 (0)	38 (45.2)	90 (73.2)	7 (100)	20.957	0.313	<0.001
24 hour survival	33 (5.5)	23 (24.2)	0 (0)	27 (45)	72 (75.8)	4 (100)	17.511	0.332	<0.001
Hospital discharge	9 (52.9)	10 (22.2)	0 (0)	8 (47.1)	35 (77.8)	1 (100)	5.843	0.308	<0.001

min: Minute; χ^2: Chi-Square; ROSC: Return of spontaneous circulation.

values presented in the literature. Our hospital is a four-floor building. Each floor is 90 meters long. The closest CBT to respond was 30 meters away and one floor above, and the furthest unit was 150 meters far and 4 floors above. Other than differences in distances between response units and the patient in arrest, the most important factor in the success of the CBT is considered to be the fast movement of the team members, personal qualifications and frequent reviews of scenarios for responding to arrests.

Studies have demonstrated that one of the most important factors in the prognosis of patients who underwent CPR was the duration of resuscitation.[12,26] In a study by Shin et al., the duration of CPR varied between 26.6 and 30.5 min.[26] Other studies reported that patients in which the resuscitation procedure lasted more than 10 min had higher mortality, whereas survival rates increased after the resuscitations was successfully completed in less than 10 min.[19,27] The duration of resuscitation was 12.3-18.9 min. in an in-hospital cardiac arrest study conducted by Vinay et al. and 20.4-17.7 min in a study by Möhnle et al.[19,27] In this study, the duration of CPR in Groups 1 and 2 was 22.8±7.7 and 25±11 min, respectively. These values are similar to those obtained in the other studies. The statistical difference in the duration of CPR in Groups 1 and 2 may be related to the high rate of VF/pVT type of initial rhythm.

The findings regarding the initial rhythm types at the time of arrest vary in the literature. In some studies, the most frequently observed initial rhythm at the time of arrest was reported as VF/pVT, whereas asystole was reported as the most frequently observed initial rhythm in other studies.[13,16,19,24] In a study by Jones et al. the initial rhythm most frequently observed (43.7%) when the arrest team reached the case was asystole.[28] Nadkarni et al. found that 23% of initial rhythms were VF/pVT and that 35% were asystole.[19] In our study, asystole was the most common rhythm observed in CPR, followed by VF/VT. However, the increase in the rate of VF/pVT in Group 2 depended on the decrease in the CPA arrival time.

In studies survival rates in in-hospital arrests varied between 13% and 28.5%, 35% and 40%.[12,17,23,25] In the present study, the 24 hour survival rates of both groups were as high as those reported in the literature.

In the literature, the rates of hospital discharge following CPR were reported to vary between 0 and 42%, with the most commonly observed rates being between 15 and 20%.[26] The hospital discharge rate was 18% in a study including 36,902 patients.[19] In other studies, the hospital discharge rates was 13% in the U.S, 15% in Canada, 15% and 17%.[29-32] In a study of 115 cases, the hospital discharge rate was 15% in the USA, 16% in Canada, 17% in the UK and 14% in other European countries.[33] The differences in the wide range of hospital discharge rates reported in the literature may depend on several factors such as the ages and accompanying diseases of the patients, the uni or multicentre organization of the study, the continents where the studies were conducted and the characteristics of the resuscitation teams. In our study, the 4.6% hospital discharge rate found for Group 1 is nearly at a ratio of 1/3 compared to similar studies conducted in Europe and America. The hospital discharge rate was 11.2% after the introduction of code blue (Group 2). However, even this hospital discharge rate is lower than that reported in similar studies.

The initial rhythm of asystole is known as a fatal rhythm. The ROSC with an initial rhythm of asystole was observed to be as low as 35%.[26] 24 hour survival (10-35%) and hospital discharge rates (5-7.5%) were also low.[9,33] In cases with an initial rhythm of VF/pVT, the ROSC was 72-64%, 24 hour survival was 35-41% and hospital discharge is 36-24%.[14,17,18,26] These rates are higher compared to those observed in cases with an initial rhythm of asystole.[18-20] In our study, the ROSC, the 24 hour survival and the hospital discharge rates of patients with an initial VF/pVT rhythm at the time of arrest increased from 26.8%, 24.2% and 22.2%, respectively before the introduction of code blue (Group 1) to 73.27%, 75.8% and 77.8%, respectively, after code blue (Group 2). This

increase is above the values reported in the literature. The fact that VF/VT ratios in group 2 are approximately three times more than group 1 is an indication that CPAs were reached earlier after the introduction code blue.

In a study by Peberdy et al., the ROSC rates with respect to the time between arrest and the time period of CPR were 42% in cases less than 15 min, 42% in cases between 15-35 min and 16% in cases more than 35 min.[17] Möhnle et al, reported rates of 66.9%, 52.7% and 36.2% in CPRs performed less than 15 min after the arrest, whereas these rates decreased to 33%, 21% and 9.6% in CPRs performed more than 15 min after the arrest. Our findings are similar to those obtained in the study by Peberdy et al., for the patients who underwent CPR in the 15-35 min group.[17] According to the results of our study, although the ROSC and the 24 hour survival and the hospital discharge rates in CPR performed for less than 20 min did not show a statistically significant increase after the introduction of code blue, these rates reached the values reported in the literature. This could be explained by the early response to CPR by the CBT maintained through the first use of CB and the corresponding increase in patients with an initial rhythm of VF/pVT.

LIMITATION OF THE STUDY

The limitations of our study were that the study was conducted in the form of a retrospective record review, the primary and accompanying diseases of the patients were not recorded on code blue and CPR forms, and cerebral-neurological functions were not determined at the time of discharge. Furthermore, the term 'do not attempt resuscitation' (DNAR) and related terms that apply in North American and Western European hospitals were not applicable in this study because there is no legal or ethical regulation in this area in Turkey.

CONCLUSION

According to our study, the time to the arrival of the CBT decreased, the time to the occurrence of CPR increased, the rate of rhythms monitored at VF/pVT increased and the CPR success rates increased after the introduction of the code blue call system in our hospital. However, the resuscitation time did not decrease following the introduction of code blue. Furthermore, these results show that teams organized for early response to CPA increase the success of CPR. Thus, we consider that the presence of a specialized CPR team at medical centers and the fast response of this team to patients in CPA can contribute positively to CPR outcomes. Such outcomes can be further improved by continuously updating the experience and training of the CBT, focusing on CBT training for early resuscitation and possibly having more than one CBT if necessary.

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