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Rapid Response Team Performance in Third-Zone, in-Hospital Outdoor Code Blue Calls

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ABSTRACT

Objectives: We aimed to define the Code Blue interventional characteristics at our institution and to put forward a new parameter for the identification of teams' performance, and to discuss the differences between indoor and outdoor operations.

Material and Methods: Our study is a prospective observational survey over an 18-month period between February 1, 2014, and August 1, 2015. The dataset included the call date and the time, the call mode (by phone or bystander), the location, time to reach the location, patient's name and ID number, diagnosis, and the result. Response time was recorded in seconds, and distance between the location and the Emergency Department ED was recorded in meters.

Results: During the 18-month study period, 55 code calls occurred. The patients were placed into three groups: policlinic admission patients (63.6%, n=35), inpatients (12.7%, n=7), and visitors and hospital personnel (23.6%, n=13). The mean distance of response points from the ED was 131.1 (37–174) meters and the mean response time was 102.4 (30–180) seconds. We detected a statistical difference in distance to ED (p=0.017) and reach time (p=0.013) parameters between indoor and outdoor cases.

Conclusions: Outdoor "in-hospital" Code Blue calls and emergency cases have distinct features, which should be further investigated apart from "out of hospital" cardiac arrest and "indoor in-hospital" cardiac arrest cases. The average response speed (distance to ED divided by response time) may be a suitable parameter for examining the performances of teams in addition to average response time.

Keywords: Rapid response team, cardiopulmonary resuscitation, code blue

ÜÇÜNCÜ BÖLGEDE HIZLI MÜDAHALE EKIBI PERFORMANSI: HASTANE İÇI BINA DIŞI MAVI KOD ÇAĞRILARI

ÖZET

Amaç: Hastanemizin Mavi Kod müdahale özelliklerini tanımlamayı, ekiplerin performansını belirleyebilmek amacı ile yeni bir parametre ortaya koymayı ve bina içinde ve bina dışında yapılan müdahalelerinin farklılıklarını ele almayı amaçladık.

Gereç ve Yöntem: Çalışmamız, 1 Şubat 2014 ile 1 Ağustos 2015 tarihleri arasındaki 18 aylık süreyi kapsayan prospektif gözlemsel bir araştırmadır. Veri seti; çağrı tarihi, saati, çağrı şekli (telefon veya ayaktan), yer, müdahale süresi, hasta adı, kimlik numarası, tanısı ve sonucu bilgilerini içermektedir. Müdahale süresi saniye, yerin acil servise uzaklığı metre cinsinden kaydedilmiştir.

Bulgular: 18 aylık süre içerisinde 55 kod çağrısı meydana geldi. Hastalar üç grupta ele alındı: poliklinik başvuru hastaları (63.6%, n=35), yatan hastalar (12.7%, n=7), ziyaretçiler ve hastane çalışanları (23.6%, n=13). Müdahale yerlerinin acil servise ortalama uzaklığı 131.1 (37-174) metre, ortalama müdahale süresi 102.4 (30-180) saniye idi. Bina içi ve bina dışı olguların acil servise mesafe (p=0.017) ve ulaşma süresi (p=0.013) parametreleri arasında istatistiksel anlamlı fark tespit ettik.

Sonuç: Hastane içi bina dışı Mavi Kod çağrıları ve acil olgularının hastane dışı kardiyak arrest ve hastane binası içinde meydana gelen kardiyak arrest olgularından farklı olarak ayrıca incelenmesi gereken farklı özellikleri vardır. Ortalama müdahale hızı (acil servise uzaklığın müdahale süresine bölünmesinin sonucu), ekiplerin performansının değerlendirilmesinde ortalama müdahale süresine ek uygun bir parametre olabilir.

Anahtar sözcükler: Hızlı müdahale ekibi, kardiyopulmoner arrest, mavi kod

Hospital complexes include both medical and social facilities. Large numbers of patients, visitors, and employees spend time in hospitals, especially during daytime hours, when they may encounter accidents, acute medical problems, or other types of traumas. Hospital emergency codes are important in these emergent situations. "Code Blue" is used for resuscitation-team organization for responding to in-hospital cardiopulmonary arrests. This system also includes personnel training and simulations of code scenarios. Communication systems (e.g. pagers, internal telephone systems, cellular phones and push-button systems), the number of participants, and the specialty of the physician team leader may vary according to the capabilities and resources of the center. Rapid response teams (RRTs) are medical emergency teams that respond to in-hospital cardiopulmonary arrests designated as various 'codes,' most often Code Blue (1).

Basic life support and advanced cardiovascular life support interventions require early recognition, immediate high-quality cardiopulmonary resuscitation (CPR), and rapid defibrillation (2). However, in-hospital staff CPR performance can be negatively affected by several factors, including poor retention of CPR skills and hesitation to initiate CPR due to the fear of harming the patient (3,4). Therefore, trained and well-equipped professional CPR teams are necessary. The current literature reports that implementation of Code Blue protocols reverses the increasing trend toward critical deterioration and improves survival rates after in-hospital CPR interventions (5,6). However, there is a wide variability in resuscitation care among hospitals and within practices (7). The literature on Code Blue interventions is mainly concerned with events occurring in intensive care units and hospital ward areas, while events in outdoor locations and social areas of hospitals are rarely studied.

We aimed to define the Code Blue interventional characteristics at our institution, in particular bystander characteristics, communication systems, team response time, scene of event, and distance from the emergency department (ED). In addition to time and distance variables, we calculated the response speed of our RRT. In this way, we aimed to put forward a new parameter for the identification of Code Blue performance parameters, and to discuss the differences between indoor and outdoor Code Blue operations.

Materials and methods

Study center characteristics

Our study center is a three-story complex hospital containing 160,000 m^2 of property (29,500 m^2 of indoor area). The hospital's healthcare staffs (doctors, nurses, auxiliary staff, patient transporters, and paramedics) undergo basic life-support training annually, but the staffs were not informed about this study in order to prevent the Hawthorne effect. During the study period, there were a total of approximately 2,000 ED patient admissions per month.

Study characteristics

We performed a prospective observational study over an 18-month period between February 1, 2014, and August 1, 2015. Our RRT was composed of an emergency medicine specialist physician, a nurse, and a paramedic. We used the internal telephone system as the Code Blue communication method, and placed printed signs displaying the ED phone number at various sites throughout the indoor and outdoor areas of the hospital. In the case of a Code Blue call from an indoor site, the RRT moved to the event area with emergency aid kits, while for outdoor calls, we arrived with the ambulance. The ED registration officer recorded the call date and time, the call mode (by phone or bystander), and the location. After the procedure, the RRT physician completed the dataset for the patient (time to reach the location, patient name and ID number, diagnosis, and result). Response time was recorded in seconds, and distance between the location and ED was recorded in meters.

Statistical analysis

We recorded the study data in a Microsoft Excel file and the analysis was performed with SPSS version 17.0. We reported descriptive statistics as frequency (n), percentage (%), and ± standard deviation (SD). We used the Kolmogorov–Smirnov test of normality to **investigate whether variables were normally distributed.** We used Student's t-test to compare the indoor and outdoor variables.

Ethical issues

We obtained ethics approval from the Military Medical Academy Ethical Board, and conducted the study in accordance with the principles of Declaration of Helsinki.

Results

During the 18-month study period, 55 code calls occurred. The mean age of the patients was 28.43 years (range 17–80 years), and 14.5% (n=8) of the patients were

female while 85.5% (n=47) were male. The patients were placed into three groups: policlinic admission patients (63.6%, n=35), inpatients (12.7%, n=7), and visitors and hospital personnel (23.6%, n=13). Sixty percent (n=33) of the code activations were made by non-healthcare professionals and 87.2% (n=48) were made via telephone calls. The mean distance of response points from the ED was 131.1 (37–174) meters and the mean response time was 102.4 (30–180) seconds. The calculated speeds of the RRT in reaching the scene (distance to ED/response time) are shown in Table 1. Code Blue calls was made for 13 different medical reasons (Table 2). Cardiopulmonary resuscitation was performed for only one patient, which was a suicide case in the visitor group. Our study's Code Blue interventions resulted in five different outcomes, as shown in Table 3.

Table 1. Distance, time and speed results of code blue interventions

	Indoor n=35	*Outdoor n=20*	*P**
Distance to Emergency Service (meters) (min-max-mean)	118.63±55.96 (37-170)	152.95±35.84 (80-174)	0.017
Reach time (seconds) (min-max-mean)	92.57±38.07 (30-180)	119.50±36.05 (60-180)	0.013
Reach speed (meters/seconds) (min-max-mean)	1.32±0.61 0.47-2.83	1.34±0.31 (0.63-1.93)	0.886

*: Student's t-test

Table 2. Reasons of code blue calls

Diagnosis after assessment	*Outpatient group (policlinic admissions) n=35*	*Inpatient group n=7*	*Visitors and employees n=13*
Seizure mimickers and conversive disorder	25	-	2
Road traffic accident	-	-	3
Gunshot injury	-	-	1
Seizure	3	5	1
Head trauma	-	-	2
Assault	-	-	1
Hypotension	-	1	-
Vertigo	1	-	-
Chest pain	2	-	1
Vasovagal syncope	2	-	-
Ventricular tachycardia	1	-	1
Dyspnea	1	-	-
Fall from high	-	-	1

Table 3. Results of code blue interventions

Results of Code Blue Interventions	*Number of Patients, n (%)*
Discharged	36 (65 %)
Transferred to Military Medical Academy Training Hospital ED by ambulance	7 (12.7 %)
Hospitalized	4 (7.2 %)
In-patients were intervened on site and hold on hospitalization	7 (12.7 %)
Dead	1 (1.8 %)

Discussion

The current CPR guidelines make a clear distinction between out-of-hospital cardiac arrest (OHCA) care and in-hospital cardiac arrest (IHCA) care (8). This life-support concept accepts OHCA care as a reactive resuscitation intervention, and IHCA care shifts from reactive interventions to preventions. However, our study results show that there is a third resuscitation zone between IHCA and OHCA: outdoor in-hospital cardiac arrest. These cases occur within the borders of a hospital's property, but not within clinics, intensive care units, or surgical wards; rather, they occur in the social areas, roads, and main entrance of the hospital. We observed that these 'third zone' cases feature some peculiar variables that distinguish them from IHCA and OHCA cases. First, nearly all (19/20) of these Code Blue calls were made by non-healthcare professionals. Upon the arrival of the RRT team, it was observed that the non-healthcare-provider bystanders did not intervene with the patients, even in that one cardiopulmonary arrest case. We assess that the bystanders' expectation of the healthcare team's immediate arrival may be a factor in this behavior. In non-indoor cases, the ambulance plays a crucial role both in reaching the scene and in transferring the patient to the ED. As the ED is the destination and follow-up center for these cases, the ambulance and ED personnel all must be aware of their important roles. These 'third zone' cardiopulmonary arrests and other emergency cases should be investigated in further studies.

Code Blue is the best-documented and most-studied type of hospital emergency code system. Proper education about this system has positive effects on the CPR skills and level of competence in resuscitation among team members (9,10). Incorrect Code Blue activations and misuse of the system are controversial issues. Common practice is to refer to non-cardiopulmonary arrest Code Blue calls as 'inappropriate.' Eroğlu et al. reported that only 8 out of 89 Code Blue calls were for cardiopulmonary arrest in a 5-month observational study (11). Bayramoglu et al.

reported that 402 (84.5%) of 474 Code Blue calls were determined to be inappropriate in a 9-month retrospective survey (12). Kaernested et al.'s survey showed that 231 of 311 Code Blue calls (74%) were inappropriate (13). In our study, only one call was for cardiopulmonary arrest; the other 11 patients had life-threatening conditions such as ventricular tachycardia, dyspnea, chest pain, fall from a height, and road traffic accidents (Table 2). High rates of inappropriate activation are considered an obstacle to the effective use of this system. However, non-cardiopulmonary arrest cases may deteriorate quickly. On the other hand, criticism of hospital personnel's threshold for calling the RRT may result in delayed or unperformed Code Blue calls. We suggest that the defining calls for non-cardiopulmonary arrest cases as 'inappropriate' may negatively affect both the threshold for calling for medical help and the RRTs' attention and intervention performance.

In our study, a significant portion of Code Blue calls were initiated for seizures and seizure-like events (Table 2). The vast majority of seizures are self-limiting and end within 5 minutes, but a generalized seizure may be the first symptom of cardiac arrest event (14,15). We concluded that after the initial examination by the RRT and the exclusion of an epileptic status, inpatients may be followed at clinics. Outpatients, visitors, and employees should be transferred to the ED for further evaluation and a neurology consultation in the event of an epileptic seizure.

Time between cardiac arrest and initiation of basic life support is of vital importance in potential morbidity and mortality caused by hypoxic-ischemic brain damage. Even in cases of witnessed cardiac arrest, after ventricular fibrillation and an estimated CPR initiation interval under 15 minutes, 6-month mortality is 40%–55% (16). It is therefore important to establish how quickly the Code Blue team must arrive at the scene and begin performing CPR. According to the current basic life-support guidelines, the answer to this question is 'immediately' (3). However, this interval can be prolonged for several reasons, particularly in OHCA and outdoor IHCA cases. After cessation of cerebral circulation, neuronal oxygen stores are consumed within 20 seconds and brain glucose and adenosine triphosphate deposits are consumed within 5 minutes (17). Therefore, we hypothesize that an RRT response time of less than 5 minutes after total collapse may be accepted as suitable. Consistent with this hypothesis, Cummins et al. reviewed 1,297 witnessed OHCA cases and reported that CPR must be started within 4–6 minutes from the time of collapse in order to increase cardiac susceptibility to defibrillation (18). Code Blue studies have formulated a quantitative definition of 'average response time' to evaluate the performance of RRTs' reactions to IHCA events. Bayramoğlu et al. reported this time to be 4.31±2.25 minutes (12). Garcia et al. reported that 90 patients were treated within one minute in their survey. However, these surveys were performed at different centers with varying distance and transportation conditions. In addition, our results showed that indoor and outdoor IHCA interventions had different distance and time variables (Table 1). We conclude that the average response speed can be an additional parameter for examining RRTs' performance at different hospitals and even that of different RRTs within the same hospital.

Our study had several limitations, primarily the limited number of total Code Blue calls and the occurrence of only one cardiopulmonary arrest. The hospital's military status and the low total patient admission numbers were the major reasons for this. The single-center observational methodology was another limitation of our study.

Conclusion

The inappropriate perception of non-cardiopulmonary arrest Code Blue calls may have unfavorable effects on bystanders' willingness to place calls for medical help, and on the RRTs' attention and interventional performance. Outdoor in-hospital Code Blue calls and emergency cases have distinct features, which should be further investigated apart from OHCA and indoor IHCA cases. The ED plays a crucial role in the evaluation and follow-up of these cases, and the average response speed (distance to ED divided by response time) may be a suitable parameter for examining the performances of RRTs in addition to average response time.

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