THE EFFECTS OF ESTABLISHING A QUICK-RESPONSE RESUSCITATION SYSTEM ON CARDIOPULMONARY ARREST SURVIVAL

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ABSTRACT

Objective: To evaluate the effects of establishing a quick-response resuscitation system on cardiopulmonary arrest survival.

Methods: A new system was set up to allow a team of trained physicians, pediatricians, anesthetists, critical care nurses and respiratory technicians to reach patients quickly to start resuscitation of in-hospital ward patients in cardiopulmonary arrest as soon as possible. The records of consecutive resuscitative attempts in the year prior to initiating the new system (206 patients) and the two years following the initiation of the system (456 patients) were examined.

Results: The time of arrival of the resuscitation team was cut down by the new system from 10 minutes to 1 minute and 15 seconds. The time to first defibrillation was also reduced from 14 minutes to 2 minutes and 12 seconds. The survival of patients after 24 hours in the ICU following resuscitation was increased from 3.9 % prior to the new system to 41 % and the rate of discharge of patients from hospital was increased from 2.5 % to 22.8 %.

Conclusion: The most notable improvement in the system was the decrease in the time needed to reach the patient and to first defibrillation, when needed. This has resulted in a significant improvement in survival rate of patients with cardiopulmonary arrest in general hospital wards.

Key words: Establishing quick-response, Resuscitation, Cardiopulmonary, Survival.

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Introduction

King Hussein Hospital is the largest military tertiary care hospital in Jordan, being the main hospital of King Hussein Medical Center in Amman. It has over 583 beds in 12 main wards, with a renal dialysis unit, an intensive care unit (ICU), recovery ward and an intermediate care unit.

The hospital was set up initially in 1973 such that each ward had its own staff of resident doctors and nurses. The resident doctors would be taking care of all the patients on that ward regardless of their illness. If a cardio-respiratory arrest occurs, the doctors and nurses in the ward would do the initial resuscitation needed and take the patient to the ICU or recovery ward. During the last decade, with the establishment of the different subspecialties, this organization was changed such that different teams of doctors of various subspecialties are taking care of their patients in different wards. This meant that there were periods of time when no doctor would be found in a certain ward while another ward may be harboring a dozen of doctors doing their separate rounds.

This organizational change, although may have provided focused specialized care, has affected the immediate availability of doctors on the wards for resuscitation of cardiopulmonary arrests. Studying in-hospital arrests has proven that even if basic cardiopulmonary resuscitation (CPR) was done promptly, survival rates were dismal if advanced cardiac life support (ACLS) with early defibrillation was not done rapidly [(1)]. Hence there was a need to establish a new multi-disciplinary system to deal with the patients and the anxiety this situation created among the ward nurses and present family members who were often dissatisfied with the delay in the response time of the doctors and the general handling of the patient. This study examines the new system and its results on the

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survival of patients who develop cardiopulmonary arrest in the general wards of the hospital.

Methods

Establishing the Resuscitation System:

An assessment of the difficulties that were faced prior to establishing the new system was done through interviews with the staff nurses, ward matrons, resident doctors and consultants, ICU and Recovery ward staff, communication engineers, telephone operators and hospital management. It was decided that the best approach would involve the formation of a trained team of doctors, critical care nurses and respiratory therapists that would be on-call at all times and would respond to cardiopulmonary arrests in the different wards through a paging system. This was called the "CODE BLUE" system. The time of starting the resuscitation effort was calculated from the time of declaring a "CODE BLUE" by the ward nurse to the beginning of resuscitation efforts.

The "CODE BLUE" team consists of Internal medicine resident, Pediatric resident, anesthesia resident; critical care nurse and a respiratory therapist. The "CODE BLUE" team members would run to the ward upon noticing the number of the ward on the pagers. They do not need to call anyone. Upon arriving to the ward, the team would go immediately to the resuscitation room of that ward which would be at the same site in each ward. If the patient was not there yet, the team would help the nurses put the patient there as quickly as possible.

Examining the Effects of the "CODE BLUE" System:

From October 1996 till September 1997, the records of consecutive patients who were referred from a general ward to the ICU or recovery ward after a resuscitation effort was done were examined and mortality records of the general wards were examined to establish the survival rates prior to establishing the "CODE BLUE" system. The ward nurses and telephone operators were asked about the time required for doctors to arrive to the ward and start advanced cardio-pulmonary resuscitation and the time till the first defibrillation attempt was made, if any, for each case of cardiac arrest. In October 1997 the "CODE BLUE" system was started and the similar records were examined from January 1998 till December 1999. Moreover, after establishing the "CODE BLUE" system, the team leader of each resuscitation attempt would fill the "CODE BLUE" audit form which has all the details of each resuscitation attempt including the time of the call on the pager and the time of starting advanced cardiac life support and the time of the first defibrillation attempt made, if any, as well as the result of each resuscitation attempt. These forms were gathered and examined with the records of the ICU and mortality record of the general wards. Statistical method used to compare the old and new system i.e. before and after introducing quick-response resusitation system was t-test and the P-value level of significance was 0.05.

Results

Records of the resuscitative efforts of 206 patients prior to initiating the "CODE BLUE" system and 456 patients after establishing the system at King Hussein Hospital are outlined in Table I.

As shown in Table I, there was a major improvement in resuscitative efforts that was reflected by the improvement in the time to start resuscitative efforts and delivery of the first defibrillation when needed. The shortened time had led to significantly more patients being found in ventricular fibrillation and hence needing defibrillation. This has been shown to affect the outcome of patients [(2)] and in this study it has resulted in an increase in the number of patients stable enough for transfer to the ICU and recovery wards. These patients also had a lower mortality rate and (104/240) 43.3% of them survived to hospital discharge compared to (5/23) 21.7% of patients that were managed prior to the establishment of the "CODE BLUE" system. During the two years following implementation of the "CODE BLUE" system, there were 31 false alarms (not counted in Table I); three patients had seizures and were not in cardiac arrest and 28 patients had a "Do Not Resuscitate" (DNR) order. The main reason given for the latter was the relief from anxiety that the nurse and the present family with the dying patient would have by the arrival and actions of the "CODE BLUE" team. Once the order of DNR was confirmed, however, the resuscitation attempt would be halted and the primary doctor of the patient would be called to take responsibility of the situation.

Discussion

For more than 30 years, researchers have published many studies on survival after in-hospital CPR. Until recently no clear picture of success had emerged. Three major reviews of more than 50 published articles on survival after in-hospital CPR have demonstrated wide variations in survival [(3-5)]. McGrath [(3)] calculated survival rates of 38% at 24 hours (range, 13% to 59%) and 15% at hospital discharge (range, 3% to 27%). DeBard [(4)] reported survival rates of 39% at 24 hours and 17% at discharge to home. Cummins and Graves [(5)] reviewed 44 studies and calculated survival rates to hospital discharge that ranged from 3% to 27% for in-hospital cardiac arrest. Such wide variations in the rate of survival are explained largely by marked differences in inclusion criteria and outcome definitions.

In our study, we classified a cardiopulmonary arrest as the inability of the patient to keep his airway open or sustain adequate breathing or the inability to feel a central pulse. Our results are in accordance with other studies, but they also show the importance of applying

an adequate system for resuscitation as the survival to discharge was much improved from 2.5 % to 22.8 %.

The neurological condition of the patients who were discharged from hospital was not assessed. This would have helped us to realize if the patients saved by the new "CODE BLUE" system were in good medical condition to be autonomous with little medical care.

In many institutions, a member of the cardiac arrest team fills out an evaluation form like ours that assesses the quality of the resuscitation effort. These reports identify specific problems, such as the adequacy of basic life support (BLS), delay in arrival of the defibrillator or other equipment, delay in intubation and possible absence or malfunction of resuscitation equipment. These items are often described in a "comments" section on the cardiac arrest audit form. Although essential for in-hospital quality assurance, these items are usually unavailable for numerical analysis for comparisons between hospitals. The main difficulties that were reported of the old resuscitation system were delay in arrival of doctors to the ward, lack of privacy during resuscitation in open ward beds, slow access of all the resuscitation equipment and drugs to all patient beds, interference of family members with resuscitation efforts and inexperience of junior doctors and ward nurses in managing cardiopulmonary arrests. The "CODE BLUE" system dealt with this by allocation of a specific standardized room in each ward for resuscitation. This room has easy access from all beds and is identical in its location and in its layout of the equipment inside the room in the different wards. The room is kept locked during resuscitative efforts, inaccessible to family members.

Each room is kept updated and ready by the staff nurse in charge according to specific updated lists of medications and equipment and the door key was colored red for easy recognition and access. Advanced cardiac life support courses were given to all new resident doctors of all specialties in the beginning of their first year and a refresher course in the third year of residency for those still involved in the "CODE BLUE" system. Refresher basic cardiac life support courses were also given to ward nurses and detailed instructions were given to ward nurses on their role in the "CODE BLUE" system. These changes have probably contributed to the shorter resuscitation time and the better rates of survival.

A growing body of research suggests that resuscitation interventions must be performed not only early but also well conducted. Several studies document that all four of the major components of resuscitation may be performed poorly: Chest compressions and ventilation rates [6-8], defibrillation [9,10], endotracheal intubation, and administration of intravenous medications. In one study of in-hospital resuscitation, 83% of chest compression rates and 100% of ventilation rates were outside the recommended BLS guidelines [7]. Another project assessed the quality of out-of-hospital resuscitation and judged 48% of CPR efforts to be poor [8]. These observations are important because the quality of CPR efforts correlates with successful resuscitation [11]. Incorrect CPR was associated with a 14-day survival rate of 4% compared with a survival rate of 16% when CPR was performed correctly [8]. Another study demonstrated that correctly performed bystander CPR was independently associated with better survival to hospital discharge, whereas ineffective CPR was not associated with improved survival [6].

This is why we attempted to refresh the methods of proper CPR during the ACLS courses given each year in addition to BLS courses and although not numerically measured, the CPR technique during resuscitation efforts were significantly improved after the CPR refreshment sessions.

At the time of the study, the recommended CPR technique involved giving 5 chest compressions followed by one breath, the addition of active chest decompression and interposed abdominal compression and decompression that have been recently recommended may have increased our survival rates as the forward flow that can be achieved using all these four phases can reach 4.6 l/min. close to the level of normal spontaneous circulation [12].

ACLS courses given according to the recommendations of the American Heart Association have given the team members the knowledge and confidence of how to run a "CODE BLUE" and this has been previously known to improve the survival rate of hospital patients [13].

The order of "Do Not Resuscitate" (DNR) was left to the consultant taking care of each patient, although there are certain models that can predict who would survive a cardiopulmonary arrest [14], this was left to the clinical decision of the primary consultant taking care of the patient in the hospital with the help of the patient and his/her family. There were no "limited" resuscitation efforts as these were found to be futile [15] and felt to be inappropriate and if the patient did not have a DNR order, then he/she had a full resuscitative attempt.

Conclusion

The new "CODE BLUE" system established in our tertiary care hospital has resulted in a quicker resuscitative process by a qualified specialized team with significantly better survival rates of patients after 24 hours in the ICU and upon discharge from hospital. The establishment of any resuscitation system must take into account ways to shorten the time of arrival of the resuscitation team and the time to first defibrillation, as these seem to be the most important factors leading to better survival of patients with cardiopulmonary arrest in hospitals. A periodic update and refreshment of information to the resuscitation team as well as a continuous auditing process would be needed to keep the system efficient and updated which would hopefully reflect patient survival.

Table I. Comparison of different variables before and after introducing Quick-Response Resuscitation System.

Category	Prior to "CODE BLUE" system	After "CODE BLUE" system	P Value
Period of study	One year	Two years	-
Number of patients	206	456	-
Mean Age (in years)	62	63	NS
Male : Female ratio	1.2/1	1.1/1	-
History of Coronary Artery Disease	167/206 (81 %)	360/456 (79 %)	NS
History of Smoking	148/206 (72 %)	319/456 (70 %)	NS
Average time till arrival of resuscitation team	10 minutes	1 minute 15 secs	< 0. 01
Average time till first defibrillation attempt	14 minutes	2 minutes 12 secs	< 0.05
Initial rhythm of ventricular fibrillation	42/206 (20 %)	352/456 (77 %)	<0.01
Number of patients who had defibrillation	50/206 (24 %)	375/456 (82 %)	<0.001
Total number of stable patients transferred to the ICU / Recovery ward	23/206 (11 %)	240/456 (52.6 %)	< 0.05
Total number of patients stable after 24 hours in the ICU / Recovery ward	8/206 (3.9 %)	187/456 (41 %)	< 0.05
Number of patients who survived till hospital discharge	5/206 (2.5 %)	104/456 (22.8 %)	< 0.01
Total number of deaths prior to discharge	201/206 (97.5 %)	352/456 (77.2 %)	< 0.05

NS = Not Significant

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