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Assessment of In-Hospital Cardiopulmonary Resuscitation Using Utstein Template in a University Hospital

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TOK, D., KELEŞ, G.T., TOPRAK, V. and TOPCU, İ. *Assessment of In-Hospital Cardiopulmonary Resuscitation Using Utstein Template in a University Hospital*. Tohoku J. Exp. Med., 2004, **202** (4), 265-273 —— The aim of this study was to evaluate the effectiveness of in-hospital cardiopulmonary resuscitation (CPR) strategies and identify key predictors of post-CPR survival in a university hospital setting. Using a form recommended by the European Resuscitation Council, data regarding in-hospital CPR attempts from January 2001 to December 2002 were recorded and analyzed. The main outcomes of interest were immediate survival after CPR and survival to hospital discharge. Of 307 patients who suffered cardiac arrest in the study period, 103 (33.5%) were resuscitated. Of these 103 patients, 28 (27.2%) survived immediately and 12 (11.7%) survived to hospital discharge. The key predictors of immediate survival were CPR duration and initial cardiac rhythm as monitored by ventricular fibrillation/pulseless ventricular tachycardia (VF/VT). The key predictors of survival to hospital discharge were CPR duration, immediate defibrillation, Glasgow Coma Scale score, and Early Prediction Score. Together, our results suggest that in-hospital CPR strategies require improvement. They also underscore the importance of data collection and analysis in evaluating the effectiveness of in-hospital CPR strategies ——— cardiac arrest; resuscitation; survival.
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Successful cardiopulmonary resuscitation (CPR) after in-hospital cardiac arrest and its effect on subsequent quality of life depend on the availability of basic and advanced life support systems, the ability to immediately defibrillate the arrested heart, and the quality of the CPR intervention (Beuret et al. 1993; Jorgensen 1997). Assessing the effectiveness and quality of current CPR strategies, however, is difficult because it requires the systematic collection and review of data on in-hospital cardiac arrest. The so-called "Utstein template," which was developed for this purpose, defines variables that are essential for documenting in-hospital cardiac arrest and outcomes. Using this template, a joint task force of the American Heart Association (AHA)

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and European Resuscitation Council (ERC) developed a "Standard Reporting of In-Hospital Cardiopulmonary Resuscitation Form" that hospitals can use to record cardiac arrest data (Cummins et al. 1997). This form has been used at our institution for the last 2 years. In the present study, we sought to determine how well CPR is utilized at our institution and to identify key predictors of post-CPR outcome by analyzing in-hospital cardiac arrest data collected using the Utstein template-based form.

Materials and Methods

Study design and setting

The study design was a prospective study of in-hospital CPR attempts and outcomes in a university hospital setting (Celal Bayar University Hospital, Manisa, Turkey). The hospital's resuscitation team consists of an anesthesiology resident and a nurse from the intensive care unit (ICU) and a cardiologist and a nurse from the coronary care unit (CCU). The resuscitation team responds to all in-hospital cardiac arrest alarms, which are called in by telephone to the ICU, and it performs CPR according to accepted international guidelines (Council 1998). The distance between the ICU/CCU, where the resuscitation team is always on call, and the hospital's emergency department (ED) is 50 meters, and it takes the resucitation team approximately 45 seconds to reach the ED. The distance between the ICU/CCU and the farthest general patient-care ward is 150 meters, and it takes the resuscitation team 1-3 minutes to arrive there. The present study was approved by The Ethical Committee of Celal Bayar University School of Medicine.

Study population

We identified all cases of in-hospital cardiac arrest in adults (>14 years of age) that occurred between January 2001 and December 2002. Data regarding each cardiac arrest were collected on a standardized form (Cummins et al. 1997). Excluded from analysis were all cases in which the patient was already undergoing CPR on arrival at the hospital. In those cases in which the patient suffered multiple cardiac arrests, only the initial in-hospital arrest was recorded during the same period of hospitalization; this was done in order to avoid falsely elevating the rate of successful CPR and falsely diminishing the rate of survival to hospital discharge.

Study variables and outcomes of interest

Study variables included age, gender, location and etiology of cardiac arrest, time from cardiac arrest to CPR initiation, initial cardiac rhythm, immediate defibrillation (within the first 2 minutes of pulselessness), CPR duration, initial Glasgow Coma Scale (GCS), and Early Predictive Score (EPS).

Cardiac arrest was defined by the absence of a detectable pulse ("pulselessness"), by the patient's unresponsiveness, or by any arrest rhythms noticed on monitors. The location and etiology of cardiac arrest and initial cardiac rhythm were noted and recorded by the medical staff. The etiology of cardiac arrest was defined as either cardiac or noncardiac. The initial cardiac rhythm was recorded as either ventricular fibrillation/pulseless ventricular tachycardia (VF/VT) or non-VF/VT. The time of cardiac arrest was noted and recorded by the first healthcare professional to arrive at the scene of the event; the time of the first chest compressions was noted and recorded by a clinical assistant, physician, or nurse. Immediate defibrillation was defined as defibrillation within the first 2 minutes of pulselessness. CPR duration was defined as the time from the first chest compressions to immediate survival. All study subjects were divided into 2 groups according to the time they first received basic life support after cardiac arrest: <4 minutes or 4-10 minutes. The EPS is based on a scale of 1-5 that depends on the presence or absence of 5 variables related to cardiac arrest: ventricular fibrillation; gasping; unequal, slow, or normal pupil reaction; swallowing; and a witness to the cardiac arrest (DeLooz and Lewi 1989). The presence of each of these variables contributes 1 point to the total EPS.

Each patient's initial GCS and EPS were recorded immediately after successful CPR.

The outcomes of interest were immediate survival after CPR and survival to hospital discharge. Immediate survival was defined as the restoration of spontaneous circulation for >20 minutes.

Statistical analysis

Statistical analysis were performed using the Statistical Package for Social Sciences (SPSS) software (Microsoft Windows version 10.0). Student's *t*-test was used to analyze the effects of age on immediate survival and survival to hospital discharge. Fisher's exact test was used to analyze the effects of etiology, initial cardiac rhythm, immediate defibrillation, and location of cardiac arrest on survival. The chi-square test was used to evaluate the effects of time to initiation of CPR, the duration of CPR, and gender on survival. The Mann-Whitney's U-test was used to analyze the effects of initial GCS and EPS on survival. Logistic regression analysis was used to identify significant predictors of immediate survival and survival to hospital dishcarge. A value of $p<0.05$ was considered statistically significant.

Results

A total of 307 patients suffered in-hospital cardiac arrest during the study period. Of these, 103 patients were resuscitated by the hospital resuscitation team and were included in all analyses. All of these cardiac arrests were witnessed; in addition, all cardiac arrests that occurred in the CCU, ICU, and ED *(n*=84) were monitored. The immediate survival rate was 27.2% (28/103) and the survival-to-hospital-discharge rate was 11.7% (12/103) (Fig. 1). The 6-month survival rate was 10.7% (11/103), and the 1-year survival was 9.7% (10/103).

Pre-cardiac arrest factors

Immediate survival and survival to hospital discharge were not significantly associated with either patient age or gender (Tables 1 and 2). Nor were they significantly associated with the etiology of cardiac arrest, although most patients who survived to hospital discharge did have a cardiac arrest of cardiac etiology (66.7% [8/12] vs. 33.3% [4/12]) (Tables 1 and 2).

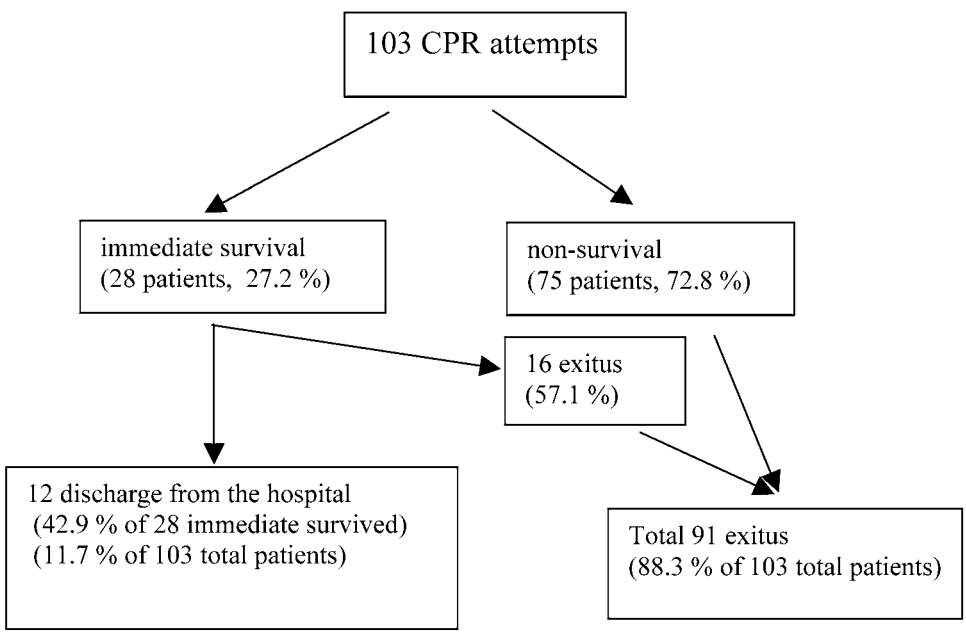


Fig. 1. Survival of CPR attempts.

TABLE 1. *Factors influencing immediate survival*

	Immediate survival (n = 28, 27.2 %)	Non-survival (n = 75, 72.8 %)	p-value
Age (Mean±S.D.)	62.6±17.3	62.2±17.3	0.9
Gender (M/F)	13/15	48/27	0.08
Etiology			
Cardiac	15 (53.6 %)	36 (48 %)	0.66
Non-cardiac	13 (46.4 %)	39 (52 %)	
Arrest location			
CCU	8 (28.6 %)	23 (30.7 %)	
ICU	4 (14.3 %)	27 (36 %)	0.06
Emergency	10 (35.7 %)	12 (16 %)	
Gen. wards	6 (21.4 %)	13 (17.3 %)	
CPR start			
<4 minutes	25 (89.3 %)	54 (72 %)	0.05
4-10 minutes	3 (10.7 %)	21 (28 %)	
Duration of resuscitation (min)			
(Mean ±S.D.)	21.3±26.5	34±14	0.02
(range)	(1-140)	(5-90)	
Initial cardiac rhythm			
VF/VT	13 (46.4%)	10 (13.3 %)	0.001
Non-VF/VT	15 (53.6%)	65 (86.7 %)	
Immediate defibrillation			
Yes	10 (35.7%)	7 (9.3 %)	0.003
No	18 (64.3%)	68 (90.7 %)	

Cardiac arrest factors

Immediate survival and survival to hospital discharge were not significantly associated with the location of cardiac arrest or with the time from cardiac arrest to CPR initiation (Tables 1 and 2). Both outcomes were, however, significantly associated with CPR duration. The mean CPR duration for patients who survived immediately (21.3±26.5 minutes; range, 1-140 minutes) was significantly shorter than for patients who did not immediately survive CPR (34±14 minutes; range, 5-90 minutes) (p=0.02) (Table 1). Likewise, the mean CPR duration for patients who survived to hospital discharge (10.6±7.2 minutes; range, 1-50 minutes) was significantly shorter than it was for patients who did not survive to discharge (33.2± 18.5 minutes; range, 5-140 minutes) (p=0.0001) (Table 2).

Immediate survival and survival to hospital discharge were significantly associated with initial cardiac rhythm. Although the initial cardiac rhythm was more often non-VF/VT than VF/VT (77.6% [80/103] vs. 22.3% [23/103]), the frequencies of these 2 variables were much closer to each other among those who immediately survived CPR (53.6% [15/28] vs. 46.4% [13/28]) (p=0.001) (Table 1) and among those who survived to hospital discharge (41.7% [5/12] vs. 58.3% [7/12]) (p=0.004) (Table 2). The mortality rate at hospital discharge was significantly higher in patients whose initial cardiac rhythm was non-VF/VT (82.4%) (p=0.004) (Table 2).

Immediate defibrillation was achieved in 17 patients (16.5%). Of these, 10 patients (58.8%) immediately survived CPR (Table 1) and 7 (41.2%) survived to hospital discharge (Table

TABLE 2. *Factors influencing discharge from the hospital*

	Discharge from the hospital (n=12, 11.7%)	Non-survival (n=91, 88.3%)	p-value
Age (Mean ±S.D.)	60.8 ± 21.1	62.5±16.8	0.75
Gender (M / F)	6 / 6	55/36	0.54
Etiology			
Cardiac	8 (66.7 %)	43 (47.3 %)	0.23
Non-cardiac	4 (33.3 %)	48 (52.7 %)	
Arrest location			
CCU	3 (25 %)	28 (30.8 %)	0.44
ICU	2 (16.7 %)	29 (31.9 %)	
Emergency	3 (25 %)	19 (20.9 %)	
Gen. wards	4 (33.3 %)	15 (16.5 %)	
CPR start			
<4 minutes	10 (83.3 %)	69 (75.8 %)	0.72
4-10 minutes	2 (16.7 %)	22 (24.2 %)	
Duration of resuscitation (min)			
(mean ±S.D.)	10.6±7.2	33.2±18.5	0.0001
(range)	(1-50)	(5-140)	
Initial cardiac rhythm			
VF/VT	7 (58.3 %)	16 (17.6 %)	0.004
Non-VF/VT	5 (41.7 %)	75 (82.4 %)	
Immediate defibrillation			
Yes	7 (58.3 %)	10 (11 %)	0.0001
No	5 (41.7 %)	81 (89 %)	

2). Immediate defibrillation was significantly associated with immediate survival (p=0.003) and survival to hospital discharge (p=0.0001).

Post-cardiac arrest factors

Both GCS and EPS were significantly associated with survival to hospital discharge (p=0.015 and p=0.001, respectively) (Table 3)

Regression analysis

CPR duration (p=0.02) and initial cardiac rhythm (p=0.02) were found to predict immediate survival (Table 4). CPR duration (p=0.002) and immediate defibrillation (p=0.006) were found to predict survival to hospital discharge (Table 5).

DISCUSSION

In the present study, we evaluated the effectiveness of in-hospital CPR strategies and set out to identify key predictors of post-CPR survival at our university hospital over the 2-year period from January 2001 to December 2002. We found that 307 patients suffered cardiac arrest in this period and that 103 were resuscitated by our hospital resuscitation team. Of the 103 resuscitated patients, 28 (27.2%) were resuscitated immediately and 12 (11.7%) survived to hospital discharge. While the hospital discharge rate in our study was comparable to the rates reported by others (DeBard 1981; McGrath 1987; Schneider and Brown 1993), the immediate survival rate was embarrassingly low when compared with

TABLE 3. *Effects of GKS and EPS on discharge from the hospital.*

	Immediate survival patients (*n*=28)		*p*-value
	Discharged (*n*=12)	Non-survival (*n*=16)	
GCS (median) (range)	6 (3-14)	3 (3-14)	0.015
EPS (median) (range)	4 (1-5)	1 (1-4)	0.001

Discharged, discharged from the hospital; GCS, Glasgow Coma Scale; EPS, Early Predictive Scores.

TABLE 4. *Predictors of immediate survival*

	Exp (B)	95% Confidence interval		*p*-value
		Lower	Upper	
Duration of resuscitation	1.05	1.00	1.10	0.02
Initial cardiac rhythm	9.76	1.31	72.65	0.02
Constant	3.74			0.30

TABLE 5. *Predictors of discharge from the hospital*

	Exp (B)	95% Confidence interval		*p*-value
		Lower	Upper	
Duration of resuscitation	1.32	1.11	1.58	0.002
Immediate defibrillation	40.74	2.97	558	0.006
Constant	0.005			0.005

the approximately 39% reported previously by others (Debard 1981; McGrath 1987; Tunstall-Pedoe 1992). We also identified key predictors of immediate survival (i.e., CPR duration and initial cardiac rhythm [VF/VT]) and of survival to hospital discharge (i.e., CPR duration, immediate defibrillation, GCS, and EPS). Age, gender, location and etiology of cardiac arrest did not consistently affect survival outcomes.

Improved survival depends greatly on prompt basic life support. The main aim of basic life support is to prevent the brain damage that can occur during prolonged cardiac arrest, since the brain is easily damaged by even a brief lack of oxygen. A systolic blood pressure <40 mmHg results in anoxic brain damage within a few minutes (Gelb and Cowie 2001). In a state of total ischemia, the brain consumes its entire store of energy in approximately 5 minutes. Therefore, the time to restoration of circulation is important and depends greatly on rapid initiation of CPR.

The benefit of prompt CPR has been demonstrated in numerous studies (Herlitz 1994, 2000; Cooper and Cade 1997; Holmberg et al. 2000; Gwinnut et al. 2000). To achieve good survival with good cerebral outcomes, basic life support must be started within 4-6 minutes and followed by advanced life support within 10-12 minutes after cardiac arrest. In the present study, all of the patients who were resuscitated had their cardiac arrests witnessed by medical staff and monitored in the ICU, CCU, or ED, and in most of those

cases (76.6%, 79/103), the patient was resuscitated within the first 4 minutes. As our data show, this prompt initiation of CPR in <4 minutes led to better immediate survival and survival to hospital discharge.

In the present study, only about a quarter of our patients (22.3%, 23/103) had VF/VT as the initial cardiac rhythm, and only 17 of them had the chance to be defibrillated immediately. This finding was unexpected since in all cases the cardiac arrest was either witnessed or monitored. However, this simply may reflect a delay in diagnosing cardiac arrest. It is also possible that some successful defibrillations were not recorded by CCU staff, which would have resulted in underreporting of VF/VT and a lower rate of immediate survival. It is also possible that the time of cardiac arrest was not accurately noted and recorded in some cases. Indeed, our hospital does not presently use or have an automatic recording system that registers the time of cardiac arrest. Instead, the exact time of cardiac arrest is determined and noted by the first medical staff member to arrive at the scene of cardiac arrest. This recording method could lead to the recording of inaccurate data and a delay in diagnosing a cardiac arrest or alerting the resuscitation team. At present, our hospital's resuscitation team is alerted by calling a nondedicated telephone line in the ICU. Sometimes, this phone number may be forgotten or the telephone line may be busy, which may in turn cause a delay in alerting the resuscitation team. Possible solutions to this would be to assign a dedicated phone line to the resuscitation team or to provide the team with mobile phones. The earlier the resuscitation team can be alerted, the better the chances of promptly resuscitating the victim and the better the chances of improving immediate survival and survival to hospital discharge.

In the present study, most of the patients who were successfully resuscitated were initially in a state of VF or pulseless VT. However, only about a quarter of those patients (73.9%, 17/23) had the chance to be defibrillated within 2 minutes of cardiac arrest. Since electrical defibrillation is the single most important therapy for the treatment of such patients, the effect of successful defibrillation on our present results is understandable. To be successful, defibrillation must be done promptly: the chances of successful recovery decrease 5-10% for each minute the patient remains in VF (Cummins et al. 1989; Hargarten et al. 1990; Cobbe et al. 1991). In our study, immediate defibrillation of patients who suffered VF/VT cardiac arrest resulted in higher immediate survival and survival to hospital discharge. Conversely, only 6.3% (5/80) of patients who suffered non-VF/VT cardiac arrest survived to hospital discharge.

In many hospitals, including ours, prompt defibrillation may be possible but not readily available. For instance, at our institution, conventional defibrillators are located in critical care units (i.e., ICU, CCU, ED, and operating rooms), and at least 1 physician trained in their use is always present there. Defibrillation can be performed promptly in these locations when indicated. Non-critical units, however, must share defibrillators. Nurses are not allowed to defibrillate patients in cardiac arrest. On general wards, defibrillation is usually performed by the physician on the resuscitation team. Thus, valuable time is often lost waiting for the resuscitation team to arrive. Moreover, automated external defibrillators are not presently used in our hospital. By training appropriate non-physician staff including nurses to use conventional and automated external defibrillators and giving them the authority to use them, it may be possible to reduce the time from cardiac arrest to defibrillation. Also, by locating conventional and automated external defibrillators in strategic areas throughout a hospital, resuscitation and immediate survival rates might be improved.

In the present study, immediate survival and survival to hospital discharge were negatively influenced by prolongation of CPR. Resuscitation time is considered to reflect the severity of ischemic injuries before and during CPR. Some investigators have estimated that, when CPR is

begun immediately, cerebral blood flow is 3-15% of normal (Koehler et al. 1963; Luce et al. 1983; Jackson et al. 1984) but decreases progressively as CPR continues (Sharaff et al. 1984) and intracranial pressures rise (Guerci et al. 1981; Bircher and Safar 1984). Nevertheless, acceptable neurological recovery has been reported even after prolonged CPR (Krug 1986). However, prolonged CPR seemed to affect the immediate survival and survival to hospital discharge in our study just as negatively as it did in other reported studies (Woog and Torzillo 1987; Murphy et al. 1989; Beuret 1993; Gwinnut et al. 2000).

Initial neurological status, which can reflect the severity of global ischemia sustained during circulatory arrest, is now an accepted predictor of post-CPR recovery (DeLooz 1989; Herlitz 1994; Jorgensen 1997). The GCS and EPS are both established measures of initial neurological status, and in the present study both correlated significantly with survival to hospital discharge.

In conclusion, our study, the first analysis of in-hospital CPR management strategies in our region, points out the need for improvements in CPR management strategies, CPR data collection, resuscitation team management, and basic and advanced life support training programs. It also points out the need for basic training in the use of conventional and automated external defibrillators for all health care providers who work in hospital settings where advanced-life-support professionals may not be immediately available. Our findings can be used in the future as an index for evaluation of in-hospital CPR management strategies and as a baseline for retrospective or prospective studies of such strategies and their effects on survival.

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