

## In-hospital Cardiac Arrest and Resuscitation Outcomes: Rationale for Sudden Cardiac Death Approach

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- Aim** To assess the frequency of cardiac arrest and outcomes and predictors of survival after cardiopulmonary resuscitation in hospitalized patients.
- Methods** We prospectively analyzed the data on all patients who experienced cardiac arrest while hospitalized at the Split University Hospital between January and December 2003. Data were collected on patients' demographic characteristics, etiology and presentation of cardiac arrest, time, site, methods, and outcomes of cardiopulmonary resuscitation.
- Results** Out of 120 cases of cardiac arrest among 32,861 hospitalized patients, 76.7% were witnessed. Ninety-six (80.0%) patients with cardiac arrest underwent resuscitation, and 22.5% of them were discharged alive. The survival rate was 20.0% at the Department of Internal Medicine, 29.2% in the Coronary Care Unit, and only 7.1% in other departments ( $P=0.058$ ,  $\chi^2$  test). Out of 92 patients with witnessed cardiac arrest, 28.3% survived to discharge, whereas only one of 28 patient with unwitnessed cardiac arrest survived to discharge ( $P=0.004$ , Fisher's exact test). More patients with cardiac arrest due to ventricular fibrillation or pulseless ventricular tachycardia survived than patients with asystole and pulseless electrical activity (47.6% vs 10.7%, respectively,  $P<0.001$ , Fisher's exact test). None of the patients with unclassified cardiac arrest survived until discharge. Cardiac arrest survivors were significantly younger ( $60.8 \pm 12.9$  vs  $71.1 \pm 11.7$  years,  $P<0.001$ , Student t-test). Sex had no influence on survival. There were no significant circadian or hospital shift differences in the frequency rate of cardiac arrest, but the rate of successful resuscitation was lower during the night shift.
- Conclusion** The rate of successful resuscitation was higher in the coronary care unit, during the day and in younger witnessed cardiac arrest patients with ventricular fibrillation or pulseless ventricular tachycardia.

Cardiac arrest is the main cause of sudden cardiac death (1,2). In industrialized countries, the rate of sudden cardiac death is rather high, ranging between 1 and 2 per 1,000 in adult population (1,2). The incidence of sudden cardiac death has been estimated at 6,000 per year in Croatia (3), 600 in the Split-Dalmatian County, and 300 in the city of Split itself. In the US, the incidence of sudden cardiac death exceeds the pooled mortality from acquired immunodeficiency

syndrome, breast and prostate cancer, home fire, firearms (in peacetime) and traffic accidents (4).

The single most important cause of cardiac arrest in the adult population is coronary heart disease (1,2). Incidence of cardiac arrest in inpatients has been estimated at 3-4/1,000 hospitalized adults (5), of whom only 20-50% are successfully resuscitated and discharged, depending on the level of cardiopulmonary resuscitation effectiveness (6,7). In other words, the risk of inpa-

tient death after cardiac arrest remains as high as 50-80% and has not substantially changed over the past 40 years (8).

Ventricular fibrillation is a major cause of sudden cardiovascular collapse, occurring in 75–80% of the cases, whereas bradyarrhythmias are less frequent (1). The only effective treatment for ventricular fibrillation is prompt defibrillation, as the probability of survival decreases by 7-10% with every minute of delay (9,10). Another 5-10 minutes can be gained by the basic life support procedures. Therefore, the International Liaison Committee on Resuscitation (ILCOR) guidelines (11) suggest that emergency care for cardiac arrest should include defibrillation within 3 minutes in a hospital setting, and within 5 minutes elsewhere. The use of automated external defibrillators and launch of large-scale training programs for potential resuscitators, particularly nurses, is recommended (9-11). Outside hospital, firefighters, police officers, and others should be included in this endeavor after a respective short-term cardiopulmonary resuscitation training (11). For the time being, defibrillators are readily available in coronary care units and in some intensive care units only, where the staff is properly trained in basic life support and defibrillation. Outside these units, both equipment and staff training are insufficient, resulting in unacceptably low success rates (12).

A traditional procedure in cases of suspected cardiac arrest is first to call a physician on duty and then to transfer the patient "urgently" to a coronary or some other intensive care unit (ICU). In such a scenario, cardiopulmonary resuscitation is generally delivered with a considerable delay, largely exceeding the recommended 3 minutes (13,14).

The incidence of cardiac arrest and survival rates have been investigated in many studies (15-17), but there are little data on the relation of patient's age and sex, cardiac arrest type, site and time of cardiopulmonary resuscitation, and witnessing of cardiac arrest with the survival of these patients (8,17-19).

The aim of this study was to assess the frequency of cardiac arrest and resuscitation outcomes in Split University Hospital; to determine the probability for an adult inpatient to sustain cardiac arrest, undergo cardiopulmonary resuscitation, and be discharged alive; and to assess the association between the survival rate and patient's

age and sex, cardiac arrest type, the site and time of cardiopulmonary resuscitation, and witnessing of cardiac arrest.

## Patients and Methods

A prospectively designed study was conducted at the Split University Hospital, a 1,350-bed facility that covers a population of over 450,000 people and has 30,000-35,000 hospital admissions per year. We determined the frequency of cardiac arrest and resuscitation outcomes in patients aged >18 years who were admitted to the Split University Hospital between January 1 and December 31, 2003.

### Patients

The study included all adult patients with cardiac arrest from the Departments of Gynecology and Obstetrics, Neurology, Oncology, Otorhinolaryngology, Ophthalmology, Psychiatry, Pulmonology, Radiology, Surgery, and Internal Medicine. The Department of Internal Medicine consists of eight divisions, as follows: Coronary Care Unit, Cardiology, Clinical Pharmacology, Endocrinology, Gastroenterology, Rheumatology and Immunology, Hematology, and Nephrology.

We did not include patients from the Departments of Anesthesiology and Pediatrics. The exclusion criteria were sudden death due to trauma, intoxication or end-stage non-cardiac disease; death in emergency and operating rooms, including pediatric surgery; incomplete medical records, and out-of-hospital arrest.

### Method

Cardiac arrest was defined as the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation (20). A witnessed cardiac arrest was defined as monitored arrest or arrest seen or heard by an identifiable person (20). We collected the data after a reported cardiac arrest and attempts of resuscitation at the above-listed departments. The data were analyzed by three investigators (DR, VC, and NP) to adjudicate the event. If cardiac arrest was confirmed, the report forms were further processed. Interviews with cardiac arrest witnesses within 24 hours facilitated the cardiac arrest validation process. The data were entered in a database according to the Utstein style guidelines and reporting templates (20), used in our Hospital. The templates contained data on patient's age, sex, main diagnosis,

and demographic characteristics; etiology and presentation of cardiac arrest; and time, site, method, and success of cardiopulmonary resuscitation, with a special reference to outcome (20). Case history and autopsy findings were attached when appropriate. Cardiac arrest classification was based on the initial electrocardiographic (ECG) evaluation performed immediately before or during the cardiopulmonary resuscitation. There were only two possible outcomes: died in hospital or discharged alive.

### Statistical Analysis

Quantitative data were presented as means with standard deviations ( $\pm$ SD), and 95% confidence intervals (95% CI). To compare frequencies,  $\chi^2$  test or Fisher's exact two-tailed test were used, and Student's unpaired t-test was applied to compare distributions.  $P < 0.05$  was considered statistically significant. Statistica 6.0 software package (StatSoft Inc., Tulsa, OK, USA) was used for all statistical analyses.

### Results

Cardiac arrest occurred in 120 out of 32,861 patients hospitalized in Split University Hospital at the analyzed Departments between January 1 to December 31, 2003, yielding a frequency rate of 3.65/1,000 patients (Table 1). Seventy-four (61.7%) of 120 patients with cardiac arrest were men with a mean age of  $68.9 \pm 12.7$  years. Only 27 of them survived and 93 died, accounting for 12.5% (95% CI, 9.9-14.9) of 962 cumulative hospital deaths in 2003. The highest rate of 92 (76.7%; 95% CI 67.6-85.7%) cases of cardiac arrest was recorded at the Department of Internal Medicine, mostly in the Coronary Care Unit (72 events, or 60.0%), whereas other departments accounted for 28 (23.0%) events.

Cardiopulmonary resuscitation was performed in 96 (80.0%) of the cardiac arrest patients. In 20.0% of the cases where resuscitation was not performed, cardiac arrest was either unwitnessed

or more than 20 minutes had elapsed since the onset. Successful cardiopulmonary resuscitation followed by a hospital discharge was achieved in 27 (28.1%; 95% CI, 17.4-38.9) out of 96 patients with cardiac arrest and performed resuscitation. At the Department of Internal Medicine without Coronary Care Unit, the rate of successful resuscitation and hospital discharge was 20%. In the Coronary Care Unit, resuscitation was performed in 68 of 72 cardiac arrest patients, of whom 29.2% were discharged. There were no attempts of prolonged resuscitation in Coronary Care Unit for three patients, due to myocardial rupture and in one due to the rupture of aortic aneurysm confirmed by transthoracic echocardiography. In other departments, only two out of 28 patients with cardiac arrest were successfully resuscitated and discharged alive (Fisher's exact two-tailed test;  $P = 0.037$ ; Table 1).

There were 92 (76.7%) witnessed and 28 (23.3%) unwitnessed cardiac arrest patients. According to the type of cardiac arrest on ECG, ventricular fibrillation and pulseless ventricular tachycardia were diagnosed in 42 (35%) patients, asystole and pulseless electrical activity in 56 (46.7%), whereas no ECG recordings were available in the remaining 22 (18.3%) patients. These 22 patients, 6 witnessed and 16 unwitnessed, did not survive to discharge. Thirty-five cardiac arrests occurred between 8:00 AM and 4:00 PM, 26 between 4:01 PM and 12:00 PM, and 30 between midnight and 7:59 AM. Less than 50% of our patients had a verified coronary heart disease (Table 2).

**Table 2.** Characteristics of patients with cardiac arrest in Split University Hospital in 2003

Characteristic*	No. (%) of patients
Sex:	
men	74 (61.7)
women	46 (38.3)
Cardiac arrest:	
witnessed	92 (76.7)
unwitnessed	28 (23.3)
Cardiac arrest etiology:	
VT/VF	42 (35.0)
ASY/PEA	56 (46.7)
unknown	22 (18.3)
Time of cardiac arrest onset:	
08 AM-04 PM	35 (29.2)
04 PM-12 PM	26 (21.7)
00 AM-08 AM	30 (25.0)
undefined	29 (24.2)
Previous coronary heart disease:	
present	53 (44.2)
absent	30 (25.0)
unknown	37 (30.8)

\*Abbreviations: VT/VF - ventricular tachycardia/ventricular fibrillation; ASY/PEA - asystole/pulseless cardiac activity.

**Table 1.** Cases of cardiac arrest and cardiopulmonary resuscitation outcomes in Split University Hospital in 2003

Patients	Department (No. of patients)			total
	Internal Medicine	Coronary Care	other	
Admitted	3,443	1,125	28,293	32,861
Cardiac arrests:				
recognized	20	72	28	120
resuscitated	18	68	10	96
discharged	4	21	2	27

Cardiopulmonary resuscitation was performed in 86 out of 92 witnessed and in 10 out of 28 unwitnessed cardiac arrests (Fisher's exact two-tailed test;  $P=0.008$ ; Table 3). A considerably higher rate of survival was observed in patients with witnessed ventricular fibrillation and pulseless ventricular tachycardia (20 out of 42 patients; 47.6%) than in those with the other two types of witnessed cardiac arrest (asystole and pulseless electrical activity), where only 6 (13.6%) of 44 patients survived to discharge from the hospital (Fisher's exact two-tailed test;  $P=0.002$ ; Table 3). Only one out of 28 patients with unwitnessed cardiac arrest (3.6%) left hospital for home care.

**Table 3.** Survival outcome after witnessed cardiac arrest and cardiopulmonary resuscitation by type of cardiac arrest in Split University Hospital in 2003

Cardiac arrest†	Type of cardiac arrest* (No. of discharged patients/No. of resuscitated patients)		
	VT or VF	ASY or PEA	unknown
Witnessed	20/42	6/41	0/3
Unwitnessed	0/0	1/9	0/1

\*Abbreviations: VT – ventricular tachycardia; VF – ventricular fibrillation; ASY – asystole; PEA – pulseless cardiac activity.

†Comparison between the witnessed and unwitnessed resuscitated cardiac arrest; Fisher exact two-tailed test,  $P=0.008$ . Comparison between witnessed VT/VF and other witnessed type of resuscitated cardiac arrest: Fisher exact two-tailed test,  $P=0.002$ .

Cardiac arrest survivors were significantly younger ( $n=27$ ;  $60.8 \pm 12.9$  years; 95% CI, 55.6-65.9 years) than non survivors ( $n=93$ ;  $71.1 \pm 11.7$  years; 95% CI, 68.7-73.5 years;  $P<0.001$ ; Table 4). Sex was not predictive of outcome; 11 women and 16 men survived cardiac arrest (Fisher's exact two-tailed test;  $P=0.824$ ; Table

**Table 4.** Significance of predictors of cardiac arrest survival in Split University Hospital by sex, age, witnessing, type of cardiac arrest, and hospital duty shift

Predictor*	No. (%) of patients		P
	died	survived	
Sex:			
women	35 (76.1)	11 (23.9)	0.824†
men	58 (78.4)	16 (21.6)	
Age (years, mean±SD)	71.1±11.7	60.8±12.9	<0.001‡
Cardiac arrest:			
witnessed	66 (71.7)	26 (28.3)	0.004†
unwitnessed	27 (96.4)	1 (3.57)	
Cardiac arrest type:			
VT/VF	22 (52.4)	20 (47.6)	<0.001†
ASY/PEA	50 (89.3)	6 (10.7)	
Work shift:			
08 AM-04 PM	23 (65.7)	12 (34.3)	0.926§
04 PM-12 PM	16 (61.5)	10 (38.5)	
00 AM-08 AM	26 (86.7)	4 (13.3)	

\*Abbreviations: VT/VF – ventricular tachycardia/ventricular fibrillation; ASY/PEA – asystole/pulseless cardiac activity.

†Fisher exact two-tailed test.

‡Student t-test.

§ $\chi^2$  test.

4). A significant difference in survival was observed between the witnessed and unwitnessed cardiac arrest (28.3% vs. 3.6%; Fisher's exact two-tailed test;  $P=0.004$ ; Table 4). Among 42 patients with ventricular fibrillation and pulseless ventricular tachycardia, 20 (47.6%) survived, whereas among 56 patients with asystole and pulseless electrical activity, only 6 (10.7%) survived (Fisher's exact two-tailed test;  $P<0.001$ ; Table 4).

The rate of successful resuscitation and discharge after cardiac arrest was lower during night shift. There were 12 cardiac arrest survivors in the morning shift, 10 in the afternoon, and 4 in the night shift ( $\chi^2=5.21$ ;  $P=0.926$ ). When the night shift data were compared with the pooled data from other shifts, the differences in successful cardiopulmonary resuscitation and discharge became significant (Fisher's exact two-tailed test;  $P=0.028$ ).

## Discussion

Our results showed a noticeable prevalence of cardiac arrest in the Split University Hospital. Less than 25% of successfully resuscitated and discharged cardiac arrest patients is close to the lowest reported resuscitation rate (6-8). The asystole and pulseless electrical activity recorded in as many as 46.7% of cardiac arrest patients and ventricular fibrillation and pulseless ventricular tachycardia in less than the expected 75-80% (1) disclose an unacceptably long delay in cardiopulmonary resuscitation delivering, when a portion of ventricular fibrillations had already degenerated to asystole at the time of ECG recording. The large number of undefined cardiac arrests also reflects delayed recognition of cardiac arrest and resuscitation attempt, as reported elsewhere (8, 15, 16). The reported survival rate following resuscitation in patients with asystole and pulseless electrical activity has been consistently low, even if overall rates after cardiac arrest were encouraging (8, 15-19, 21-23). Less than 14% of such patients were successfully resuscitated in our study. On the other hand, our success rate was highest in patients with ventricular fibrillation and pulseless ventricular tachycardia, with almost 50% of them surviving and being discharged in good conditions.

Survival rates from our study were similar to those reported previously (8, 15-19, 21-23), where survival in general hospitals did not change substantially over the past 40 years. Several-fold

higher survival rates reported in some studies probably reflect higher proportion of subjects with verified heart disease, undergoing more or less continuous ECG monitoring (15,16). We observed no significant correlation between patient's sex and resuscitation outcome, which is in accordance with previous findings (18,21-23). However, as opposed to other similar studies (8, 15-19,21-23), our analysis showed advanced age as a significant predictor of poor cardiac arrest outcome. Some large outpatient trials suggested a higher rate of cardiac arrest in the morning, and lower during the night (24). This circadian variation is presumably less pronounced in hospitals, and our results revealed a rather uniform around-the-clock pattern. Like Brindley et al (8), we have registered lower survival rates after resuscitation during night shift, possibly due to fewer staff, resulting in more cases of unwitnessed cardiac arrests and arrests with underlying asystole and pulseless electrical activity.

There are several limitations of our study. First, the design of the study was observational and information was often indirect. Second, there were many difficulties in data evaluation and interpretation, including the time of cardiac arrest onset and the recognition lag, differentiation between witnessed and unwitnessed cardiac arrest, and assessment of resuscitator competency, especially when the intervention was performed outside the Department of Internal Medicine. The Hospital departments are located in several buildings on a two-area campus, which hindered the assessment of the exact accident-to-intervention time. All of the 28 unwitnessed deaths had a resuscitation lag of more than 5 minutes. Nevertheless, resuscitation was attempted in 10 of them, and one patient was subsequently discharged to home care. In all of the witnessed cardiac arrests, the time lag to resuscitation was definitely shorter than 5 minutes, but the quality of some resuscitation attempts could be questioned. In some cases, resuscitation was initiated on a ward or corridor and continued in the Coronary Care Unit, resulting in poorer outcome and worsening the overall Coronary Care Unit results. Third, some data were missing, which was an expected but still confounding variable.

Resuscitation is not recommended for all dying patients, as its goal is to prevent premature death rather than delay inevitable one (25). It is usually performed on a patient's proxy demand, or as the resuscitator's attempt to compensate for

cardiopulmonary resuscitation delay or some other previous omission or error, compromising thus the very essence of cardiopulmonary resuscitation. On the other hand, the current organization, equipment, and skillfulness are largely inadequate to deliver appropriate resuscitation within the recommended 3-minute window (11). These are the main reasons for the gross disproportion observed in this study between the number of "resuscitated" patients and the few successfully treated and eventually discharged from hospital.

There are many difficulties in detecting individuals at risk. When the presenting cardiac arrest is the initial manifestation of the disease, or when the problem has not been properly identified in due time (silent ischemia), any urgent diagnostic test becomes obsolete. In such circumstances, the fate of a "heart too good to die" depends on premises, equipment, and professionals that happen to be around at the time of cardiac arrest onset and above all, on the nurses' training in basic life support and defibrillation. The fact that a large proportion of patients with ventricular fibrillation can be successfully defibrillated, even 90% within the first minute (1), highlights the vital importance of the necessary devices, preferably automated defibrillators (18) because of their low price, straightforward education, and impossible abuse. The great survival difference between witnessed and unwitnessed cardiac arrest unveils the role of careful patient monitoring, especially during the night, weekends, and holidays, which requires a competent team on duty all the time. Our study also had the aim to educate all the hospital's nurses (more than 600 educated registered nurses) and to install at least 20 automated external defibrillators at the non-intensive care wards (26).

Our findings may be useful to the public, the medical community, and the hospital managements to reorganize emergency cardiac arrest care, assemble emergency teams, adopt a cardiopulmonary resuscitation curriculum supporting especially appropriate nurse training, and introduce automated external defibrillators in non-coronary and non-intensive care units in and out of hospitals (e.g. in ambulances), as recommended by the European Society of Cardiology and European Resuscitation Council and as we conduct in our hospital (26,27).

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### References

- 1 Priori SG, Aliot E, Blomstrom-Lundqvist C, Bossaert L, Breithardt G, Brugada P, et al. Task Force on Sudden Cardiac Death, European Society of Cardiology. *Europace*. 2002;4:3-18.
- 2 Myerburg RJ, Castellanos A. Cardiac arrest and sudden cardiac death. In: Braunwald E, editor. *Heart disease: a textbook of cardiovascular medicine*. 5th edition. Philadelphia (PA): WB Saunders; 1997. p. 742-79.
- 3 Puljetic D. Importance and methods of evaluation of risks of malignant arrhythmias and sudden death [in Croatian]. *Lijec Vjesn*. 1999;121:188-93.
- 4 Zheng ZJ, Croft JB, Giles WH, Mensah GA. Sudden cardiac death in the United States, 1989 to 1998. *Circulation*. 2001;104:2158-63.
- 5 Buist MD, Moore GE, Bernard SA, Waxman BP, Anderson JN, Nguyen TV. Effects of a medical emergency team on reduction of incidence of and mortality from unexpected cardiac arrests in hospital: preliminary study. *BMJ*. 2002;324:387-90.
- 6 Peatfield RC, Sillett RW, Taylor D, McNicol MW. Survival after cardiac arrest in hospital. *Lancet*. 1977;1:1223-5.
- 7 Bedell SE, Delbanco TL, Cook EF, Epstein FH. Survival after cardiopulmonary resuscitation in the hospital. *N Engl J Med*. 1983;309:569-76.
- 8 Brindley PG, Markland DM, Mayers I, Kutsogiannis DJ. Predictors of survival following in-hospital adult cardiopulmonary resuscitation. *CMAJ*. 2002;167:343-8.
- 9 Cummins RO. From concept to standard-of-care? Review of the clinical experience with automated external defibrillators. *Ann Emerg Med*. 1989;18:1269-75.
- 10 Cummins RO. Emergency medical services and sudden cardiac arrest: the "chain of survival" concept. *Annu Rev Public Health*. 1993;14:313-33.
- 11 Kern KB, Halperin HR, Field J. New guidelines for cardiopulmonary resuscitation and emergency cardiac care: changes in the management of cardiac arrest. *JAMA*. 2001;285:1267-9.
- 12 Naeem N, Montenegro H. Beyond the intensive care unit: a review of interventions aimed at anticipating and preventing in-hospital cardiopulmonary arrest. *Resuscitation*. 2005;67:13-23.
- 13 Soar J, McKay U. A revised role for the hospital cardiac arrest team? *Resuscitation*. 1998;38:145-9.
- 14 Adams BD, Zeiler K, Jackson WO, Hughes B. Emergency medicine residents effectively direct in-hospital cardiac arrest teams. *Am J Emerg Med*. 2005;23:304-10.
- 15 Robinson GR 2nd, Hess D. Postdischarge survival and functional status following in-hospital cardiopulmonary resuscitation. *Chest*. 1994;105:991-6.
- 16 Rosenberg M, Wang C, Hoffman-Wilde S, Hickam D, Hickam D. Results of cardiopulmonary resuscitation. Failure to predict survival in two community hospitals. *Arch Intern Med*. 1993;153:1370-5.
- 17 Jouven X, Desnos M, Guerot C, Ducimetiere P. Predicting sudden death in the population: the Paris Prospective Study I. *Circulation*. 1999;99:1978-83.
- 18 Zafari AM, Zarter SK, Heggen V, Wilson P, Taylor RA, Reddy K, et al. A program encouraging early defibrillation results in improved in-hospital resuscitation efficacy. *J Am Coll Cardiol*. 2004;44:846-52.
- 19 Lee A, Bishop G, Hillman KM, Daffurn K. The medical emergency team. *Anaesth Intensive Care*. 1995;23:183-6.
- 20 Cummins RO, Chamberlain D, Hazinski MF, Nadkarni V, Kloeck W, Kramer E, et al. Recommended guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation: the in-hospital 'Utstein style'. American Heart Association. *Circulation*. 1997;95:2213-39.
- 21 Taffet GE, Teasdale TA, Luchi RJ. In-hospital cardiopulmonary resuscitation. *JAMA*. 1988;260:2069-72.
- 22 Murphy DJ, Murray AM, Robinson BE, Campion EW. Outcomes of cardiopulmonary resuscitation in the elderly. *Ann Intern Med*. 1989;111:199-205.
- 23 Berger R, Kelley M. Survival after in-hospital cardiopulmonary arrest of noncritically ill patients. A prospective study. *Chest*. 1994;106:872-9.
- 24 Muller JE. Circadian variation in cardiovascular events. *Am J Hypertens*. 1999;12(2 Pt 2):355-42S.
- 25 Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 2: ethical aspects of CPR and ECC. *Circulation*. 2000;102(8 Suppl):I12-21.
- 26 Approach to sudden cardiac death study [in Croatian]. Available from: [http://www.mzos.hr/zProjekti/result\\_d\\_et.asp?trazi=raki%E6&gdje=1&ID=0141021](http://www.mzos.hr/zProjekti/result_d_et.asp?trazi=raki%E6&gdje=1&ID=0141021). Accessed: September 1, 2005.
- 27 Priori SG, Bossaert LL, Chamberlain DA, Napolitano C, Arntz HR, Koster RW, et al. ESC-ERC recommendations for the use of automated external defibrillators (AEDs) in Europe. *Eur Heart J*. 2004;25:437-45.

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