BRIEF REPORT

Rapid On-site Defibrillation versus Community Program

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Keywords: advanced life support; basic life support; cardiac arrest; casino; CPR; EMS; on-site defibrillation; paramedics; prehospital care; public access defibrillation; rapid defibrillation; resuscitation; ventricular fibrillation; Windsor

Abbreviations:
ACR = Ambulance Run Report
ALS = Advanced Life Support
CPR = Cardiopulmonary Resuscitation
EMS = Emergency Medical Services
MAR = Medical Assist Report
min = minutes
OPALS = Ontario Prehospital Advanced Life Support
PAD = Public Access Defibrillation
ROSC = Return of Spontaneous Circulation
TCPR = Time to cardiopulmonary resuscitation
TDEF = Time to defibrillation
VF = Ventricular Fibrillation
VT = Ventricular Tachycardia

Web Publication: 04 November 2002

Abstract

Introduction: For patients who suffer out-of-hospital cardiac arrest, the time from collapse to initial defibrillation is the single most important factor that affects survival to hospital discharge. The purpose of this study was to compare the survival rates of cardiac arrest victims within an institution that has a rapid defibrillation program with those of its own urban community, tiered EMS system.

Methods: A logistic regression analysis of a retrospective data series (n = 23) and comparative analysis to a second retrospective data series (n = 724) were gathered for the study period September 1994 to September 1999. The first data series included all persons at Casino Windsor who suffered a cardiac arrest. Data collected included: age, gender, death/survival (neurologically intact discharge), presenting rhythm (ventricular fibrillation (VF), ventricular tachycardia (VT), or other), time of collapse, time to arrival of security personnel, time to initiation of cardiopulmonary resuscitation (CPR) prior to defibrillation (when applicable), time to arrival of staff nurse, time to initial defibrillation, and time to return of spontaneous circulation (if any). Significantly, all arrests within this series were witnessed by the surveillance camera system, allowing time of collapse to be accurately determined rather than estimated. These data were compared to those of similar events, times, and intervals for all patients in the greater Windsor area who suffered cardiac arrest. This second series was based upon the Ontario Prehospital Advanced Life Support (OPALS) Study database, as coordinated by the Clinical Epidemiology Unit of the Ottawa Hospital, University of Ottawa.

Results: The Casino Windsor had 23 cases of cardiac arrests. Of the cases, 13 (56.5%) were male and 10 (43.5%) were female. All cases (100%) were witnessed. The average of the ages was 61.1 years, of the time to initial defibrillation was 7.7 minutes, and of the time for EMS to reach the patient was 13.3 minutes. The presenting rhythm was VF/VT in 91% of the case. Fifteen patients were discharged alive from hospital for a 65% survival rate. The Greater Windsor Study area included 668 cases of out-of-hospital cardiac arrest: Of these, 410 (61.4%) were male and 258 (38.6%) were female, 365 (54.6%) were witnessed, and 303 (45.4%) were not witnessed. The initial rhythm was VF/VT was in 34.3%. Thirty-seven (5.5%) were discharged alive from the hospital.

Conclusion: This study provides further evidence that PAD Programs may enhance cardiac arrest survival rates and should be considered for any venue with large numbers of adults as well as areas with difficult medical access.

Fedoruk JC, Paterson D, Hlynka M, Fung KY, Gobet M, Currie W: Rapid on-site defibrillation versus community program. *Prehosp Disast Med* 2001; 17(2):102–106.

Status	n	Age (years)	Security	CPR	Nurse	Defibrillation	ROSC
Survived	15	59.0 ±10.00					
Time to (min)			2.2 ±2.44	2.9 ±2.19	4.9 ±3.49	7.1 ±3.25	9.6 ±3.89
number			11	12	15	15	15
Dead	8	65.2 ±11.79					
Time to (min)			0.7 ±0.82	4.8 ±2.64	7.3 ±4.68	10.0 ±3.49	12.0 ±1.41
number			6	6	6	4	2

Table 1—Mean ±standard deviation and sample size of collapse-to-event time intervals for the survivor and non-survivor groups in the Casino (n = number; min = minutes)

Introduction

It has been held that rapid defibrillation is a key element in successful resuscitation of the cardiac arrest victim.[1–10] The purpose of this retrospective study is to compare the survival rates of cardiac arrest victims within an institution that has access to rapid defibrillation versus the community at large with a traditional Emergency Medical Services (EMS) system.

Background

In Windsor, Ontario, Canada, the Casino Windsor opened its door to the public during the summer of 1994. At that time, on-site paramedics who had the ability to rapidly access and defibrillate cardiac arrest victims were employed. Shortly thereafter, Windsor Casino decided to transfer the responsibility for the provision of emergency medical care from an on-site paramedic to an on-site nurse who also provided the function of an Occupational Health and Safety nurse.

During the same period of time, the City of Windsor was involved in the Ontario Prehospital Advanced Life Support (OPALS) Study,[11] as coordinated by the Clinical Epidemiology Unit of the Ottawa Hospital, University of Ottawa. The prehospital tiered response system in Windsor during this study period consisted of Firefighter First Responders and Basic Life Support (BLS)-capable paramedics. The EMS system evolved during this study to both BLS and Advanced Life Support (ALS)-capable paramedics. The OPALS study design analyzed the survival rates of out-of-hospital cardiac arrest using the Utstein criteria. The Essex-Kent Base Hospital Program has the legislated responsibility to provide medical oversight, direction, quality assurance, and continuing medical-care education to the prehospital care providers in this study. This includes establishment of a set protocol for defibrillation in the prehospital setting. Although under no obligation to do so, Casino Windsor became a very active partner in prehospital care. The defibrillation protocols used by the Casino were identical to those for prehospital care providers in the community at large. The training for both groups was identical as were the defibrillators used for both groups.

Methods

Through collaborative efforts of the Essex-Kent Base Hospital Program, the Casino Windsor, and the University of Windsor data were collected from all cardiac arrests within the Casino during a five-year period (1994–1999). The arrest data were obtained through the Ambulance Call Reports (ACRs), fire service Medical Assist Reports (MARs), the Casino's medical records, and from the videotape recordings from the security cameras that operated 24 hours every day. The accuracy of the casino data was verified by examination of the time stamped videotape recording for each cardiac arrest within the Casino.

Results from the statistical analysis of these data were compared to the OPALS statistics for the Greater City of Windsor that were gathered through the LOEB Institute in Ottawa. The data for the Casino Windsor study consist of all patients within Casino Windsor who required defibrillator treatment between 1994 and 1999. Information gathered included: 1) Age; 2) Gender; 3) Survival/death; 4) Presenting rhythm including ventricular fibrillation (VF), ventricular tachycardia (VT), or other; 5) Performance of cardiopulmonary resuscitation (CPR, BLS) (Yes/No); 6) Down time; 7) Time of arrival of security personnel; 8) Time of arrival of a nurse; 9) Time of CPR prior to defibrillation (if applicable); 10) Time to defibrillation; 11) Time of CPR after the defibrillation; 12) Time of the return of pulse (if any); 13) EMS arrival time at the Casino; 14) Time of EMS team at patient's side; 15) Time that EMS left Casino with patient; and 16) Time of EMS arrival at hospital. The time events were coded as: "1" = time to security arrival; "2" = time to CPR prior to defibrillation;"3" = time-to-nurse arrival; "4" = time-to-defibrillation; "5" = time to return of spontaneous circulation (ROSC); "6" = time to EMS arrival to the casino; "7" = time to EMS at patient's side; "8" = time to EMS departure with patient; and "9" = time to EMS arrival at the hospital. All of the events were measured from the time of collapse.

For the greater City of Windsor, the data consist of all cases of out-of-hospital cardiac arrest between study years of 1994–1999. These data were abstracted from the OPALS study database. The data compared included; 1) Age; 2) Gender; 3) Survival; 4) Presenting rhythms (VF, VT, other); and 5) CPR (yes/no) by citizen.

Results

In Casino Windsor, there were 23 cases of cardiac arrest, 13 were male and 10 were female. Of the 23 cases, the average value of the ages was 61.2 ±10.82 (1 standard deviation) years. The minimum age was 44 years and the maximum age was 83 years. The average age for the males was 62.8 years and for the females was 59.0 years.

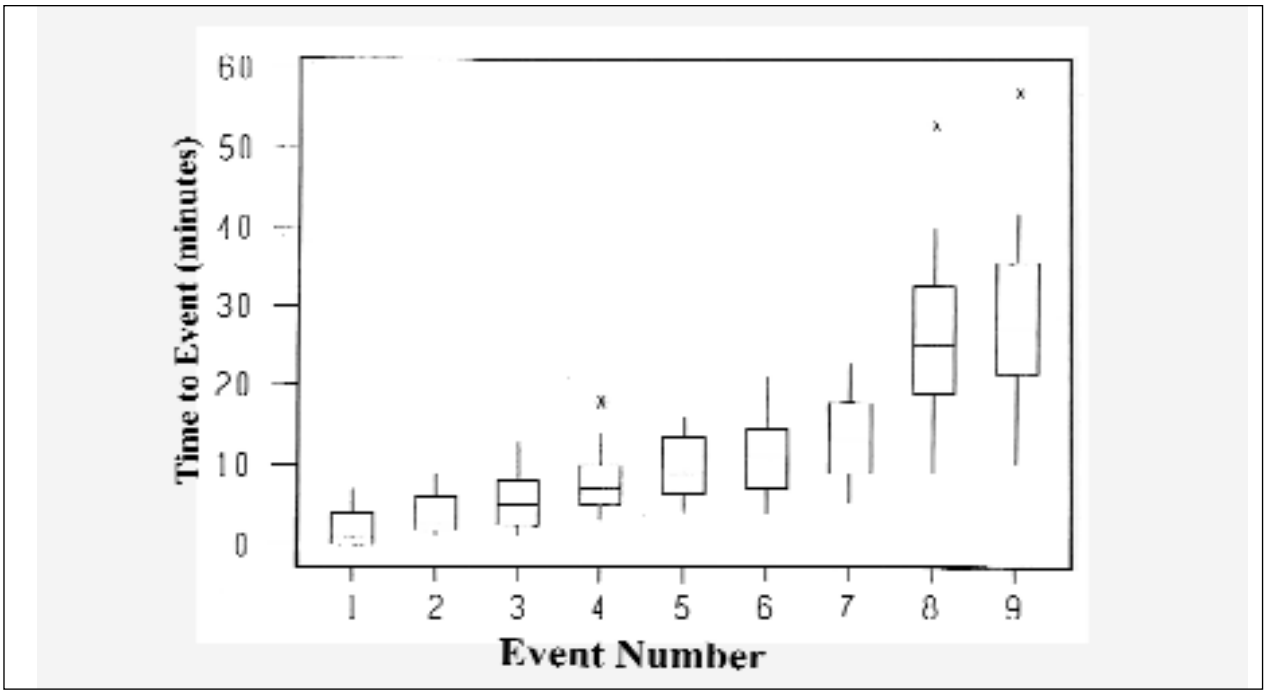

Figure 1—The nine events draws a box with boundaries at the quartiles and with a line inside the box locating the median

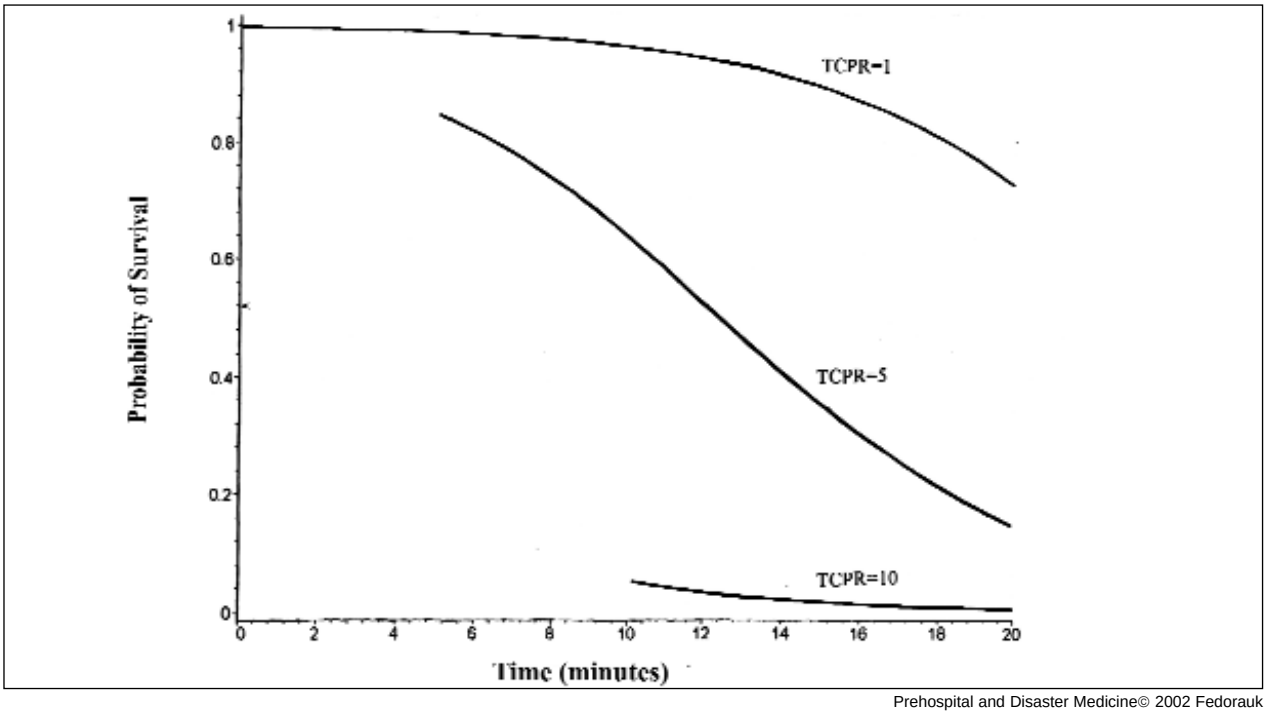

Figure 2—Comparion of the difference between the time to CPR (TCPR) versus the time to defibrillation (TDEF)

Ventricular fibrillation was the initial cardiac rhythm in 18 of the 21 cases (86%) for which data were available. One of the cases was in VT, and two had other rhythms. Of the 23 individuals from Casino Windsor, 15 survived to hospital discharge: the survival rate was 65% (95% confidence interval = 47–84%). For the 18 cases with available data, the mean value for the time interval until CPR was initiated (prior to defibrillation) was 3.6 ±2.45 minutes. For the 19 cases with available data, the mean value for the time-to-defibrillation was 7.7 ±3.87 minutes. The progression of

Time to	Sample Size	Time (minutes)
		Mean ±sd
Arrival	21	11.0 ±4.72
Patient	18	13.3 ±5.44
Depart scene	21	25.7 ±10.57
Arrival at Hospital	21	28.0 ±11.08

Table 2—Time intervals (as defined in OPALS) for prehospital emergency medical services (sd = 1 standard deviation)

TDEF	TCPR ≤5 minutes			TCPR >5 minutes		
	Survivors	Total	(%)	Survivors	Total	(%)
10 minutes	8	8	(100.0)	2	3	(66.7)
>10 minutes	2	5	(40.0)	0	0	(0.0)

Table 3—Effects of time to CPR (TCPR) and time to defibrillation (TDEF) on survival (survivors = number of survivors; total = Number of cases)

collapse-to-event time intervals classified by survival status is provided in Table 1 and in Figure 1. The survivors were younger than those who died, on average. For those who survived, the mean value for the ages was 59.0 ±10.00 years and 65.2 ±11.79 years for non-survivors. For those who survived, the mean value for the time-to-CPR was 2.9 ±2.19 minutes and was 4.8 ±2.64 minutes for those who died. The difference in mean times to CPR for non-survivors and survivors was 1.9 minutes. Similarly, the mean value for the time-to-defibrillation for survivors was shorter than it was for non-survivors by 2.9 minutes.

The median time from collapse to each event increase in the order of the sequence of the events (Figure 1). The median time to ROSC was lower than was the median time to EMS arrival (Table 2). In all of the cases, the EMS personnel arrived at the patient's side after the nurse, and after CPR had been initiated. In only one case, the EMS staff arrived prior to defibrillation.

Similar studies have compared the difference between the time to CPR (TCPR) versus the time to defibrillation (TDEF).[6] Data from the present study are presented in a similar manner in Table 3.

A stepwise regression using variables TCPR, TDEF, and the interaction (TCPR*TDEF) was constructed. The first variable entered into the model was TCPR, followed by TDEF. The p-values for TCPR and TDEF obtained were 0.1054 and 0.2630, respectively. The TCPR was fixed at values 1, 5, and 10 minutes to obtain three equations. Substituting each of these expressions for u into the logistic equation yielded three expressions, and these are plotted in Figure 2. For the fixed values for TCPR, the survival probability drops for each additional minute delay in time until defibrillation. For example, if TCPR is fixed at 5 minutes, a patient's survival probability drops from 0.74 to 0.64 as the time-to-defibrillation increases from eight to 10 minutes. Figure 2 provides an illustration of these differences. An indication of the importance of TCPR is apparent from the difference in the amplitudes of the three curves. Clearly, early CPR and early defibrillation both are important for increasing the chance of survival of a patient with sudden cardiac death.

In the greater City of Windsor, 37 of the 668 victims of sudden cardiac death survived to hospital discharge, a survival rate of 5.5% compared to 65% in the present study. A little over half of the arrests (365, 54.6%) were witnessed. The initial cardiac rhythm was VF/VT for 229 (34.3%) of the 668 cases. Citizen CPR was initiated in 120 (18.0%) of the 668 cases prior to arrival of EMS. The time from initial collapse, time to access 9-1-1, and time-to-CPR were estimated from the information provided to the EMS personnel on the scene.

Discussion

Survival rate in the currrent study (65%) were much higher than were the rates (18–33%) obtained in a similar study.[5] However, both studies indicate that a delay of 10 minutes in applying CPR increases the probability of an adverse outcome for the patient. In the logistic regression model used in the current study, survival rates plateau during the first five minutes of cardiac arrest; thereafter, they sharply decline. This is reflected in the high survival rates obtained with the on-site defibrillation program when CPR was administered early. As a caution, the amount of data used to obtain these results was small, and results should be confirmed by a much larger sample before drawing any strong conclusions.

Among the reasons for the higher survival rates obtained in the Casino than in the community, may be the presence of qualified, medically trained staff in the Casino who can administer CPR and perform defibrillation. Additionally, all of the arrests in the Casino Windsor were witnessed and the medical response began immediately.

Although this sample size is small, the outcomes seem to suggest that a two-thirds survival can be obtained for witnessed cardiac arrests when a public access, on-site defibrillation program is in place. While the OPALS data from the Windsor area provide an extensive picture of prehospital cardiac arrests (witnessed and unwitnessed), certain limitations must be noted: the accurate time of collapse, time to access the EMS system (9-1-1), and time to CPR are estimates by

the lay public or family members.

Although these data are drawn from a small sample size, the outcomes suggest that survival rates for victims of prehospital cardiac arrest may be enhanced by rapid defibrillation, preferably by on-site defibrillation. Secondly, the long-held belief that for each minute that passes from cardiac arrest to defibrillation, the patient's survival is reduced by 10%,[9,13] must be revisited. Results obtained at the Casino Windsor indicate that there is an initial plateau of approximately five minutes for defibrillation followed by a steep decline immediately thereafter. This is in contrast to the traditional linear regression curve of survival time for out-of-hospital cardiac arrests.

Currently, nurses who respond after security arrives at the scene perform the defibrillation at the Casino Windsor. This causes a delay in defibrillation. In an effort to improve the current survival rates, the Casino Windsor, in consultation with Base Hospital, currently is placing additional defibrillators to be utilized by trained security personnel. This should decrease the initial time to first defibrillatory shock by two to three minutes. Future ongoing studies will assess the effectiveness of this intervention.

Conclusions

The results of this study provide further evidence that Public Access Defibrillation programs may improve cardiac arrest survival rates. This type of on-site defibrillation program also may enhance medical effectiveness for special event venues with large numbers of adults in attendance, including sports arenas, festivals, fairs, bingo halls, banquet halls and areas of difficult medical access, such as trains and airlines. The device is relatively inexpensive and easy to use, and may dramatically increase survival rates.

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