

The dependence of successful resuscitation on electrocardiographically documented cardiac rhythm in case of out-of-hospital cardiac arrest

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Key words: resuscitation; ventricular fibrillation; Utstein style template; out-of-hospital cardiac arrest.

Summary. *Objective.* To determine the influence of electrocardiographically documented cardiac rhythm during sudden cardiac arrest on successful resuscitation among out-of-hospital deaths in Kaunas city.

Material and methods. An observational prospective study was conducted between 1 January, 2005, and 30 December, 2005, in Kaunas city with a population of 360 627 inhabitants. In this period, all cases of cardiac arrest were analyzed according to the guidelines of the Utstein consensus conference. Cardiac arrest (both of cardiac and noncardiac etiology) was confirmed in 72 patients during one year. Effective cardiopulmonary resuscitation was performed in 18 patients.

Results. The total number of deaths from all causes in Kaunas during 1-year study period was 6691. Sixty-two patients due to sudden death of cardiac etiology were resuscitated by emergency medical services personnel. Return of spontaneous circulation was achieved in 11 patients.

Ventricular fibrillation was observed in 33 (53.2%) patients. Asystole was present in 11 (17.7%) and other rhythms in 18 (29.1%) cases. Patients with ventricular fibrillation as an initial rhythm were more likely to be successfully resuscitated than patients with asystole.

Conclusions. Ventricular fibrillation was the most common electrocardiographically documented cardiac rhythm registered during cardiac arrest in out-of-hospital settings. Ventricular fibrillation as a mechanism of cardiac arrest was associated with major cases of successful resuscitation.

Introduction

The results of out-of-hospital cardiopulmonary resuscitation (CPR) are still unsatisfactory, and the outcome of initially resuscitated patients is poor (1). The main question to be answered is whether a community's emergency cardiovascular care (ECC) system can assure optimal rates of patient survival. Each community needs to examine and devise its own mechanisms to achieve the goal of optimal patient survival. Traditionally, quality assurance in ECC measures variables of separate processes, but the emphasis of quality assurance for cardiac arrest care should be expanded to examine outcome variables in the entire ECC system (2). Despite numerous data relating to this issue, a comparison of different emergency service systems and different medical approaches has been almost impossible due to the lack of unification in terminology, methods of data collection and evaluation.

In 1990, the Utstein conference established uniform terms and recommendations for the evaluation and reporting the data of out-of-hospital cardiac arrests (3). Now there is an international consensus on the importance of using standard terminology and methods for evaluation of survival and the chain of survival. The guidelines 1992 described early access, early CPR, early defibrillation, and early advanced care as essential components of a series of actions designed to reduce the mortality associated with cardiac arrest (4). The American Heart Association has used the term "chain of survival" to describe this sequence. This chain has four interdependent links: early access, early basic CPR, early defibrillation, and early advanced cardiac life support.

There are no data about out-of-hospital cardiac arrests and how the chain of survival is working in Lithuania. The purpose of this study was to apply the

Utstein style template for data collection and to determine the relationship between cardiac rhythms and outcome of resuscitation.

Methods

After obtaining approval from the local Ethics Committee, an observational prospective study was conducted between 1 January, 2005, and 30 December, 2005. In this period, all consecutive cardiac arrests confirmed by emergency medical services (EMS) personnel were analyzed. Data were collected and analyzed according to the guidelines of the Utstein consensus conference (3). The guidelines created, called the "Utstein style," allow a comparative analysis between different EMS systems. In the Utstein style template, data are categorized according to etiology (cardiac or noncardiac), whether cardiac arrests are witnessed or not, and according to the initial cardiac rhythm (ventricular fibrillation (VF), asystole, or pulseless electrical activity (PEA)). The physician on duty in the ambulance completed a specially designed case report form after returning to the rescue station.

The city of Kaunas has a population of 360 627 inhabitants. Out-of-hospital cardiac arrest, served by ambulance station, was confirmed in 72 patients during one year. Effective cardiopulmonary resuscitation was performed in 18 patients. In cases of non-cardiac etiology, there were many causes of arrests in the present study (*e.g.* trauma, suffocation, intoxication, cerebral vascular attack, *etc.*), and these cases (10 patients) were excluded. After these exclusions, the total number of cardiac arrests (62 patients) was categorized as "resuscitation attempted" and "resuscitation not attempted."

Analysis of cardiac rhythms was complicated because of many different abnormal electrocardiographic patterns and because most patients experience changing rhythms during a cardiac arrest (5). The distinction between asystole and VF was made for all patients. Detections on the surface ECG of 0.1 mm (calibrated at 10 mm/mV) were defined as asystole, whereas more than 0.1 mm – VF. PEA is a term that includes electromechanical dissociation, pseudoelectromechanical dissociation, idioventricular rhythms, pulseless ventricular escape rhythms, postdefibrillation idioventricular rhythms, and bradysystolic rhythms. For purposes of uniform reporting, all pulseless rhythms with electrical activity were defined as other rhythms. For all cases of cardiac arrest, emergency personnel reported the initial rhythm documented.

Statistical analysis

Differences between groups were analyzed using the t test and Mann–Whitney test. All data were computed with Microsoft Excel for Windows 2000, and calculations were performed using Statistica for Windows version 11.0. A p value of less than 0.05 was regarded as significant in all tests.

Results

The total number of out-of-hospital deaths from all causes in Kaunas during 1-year study period was 6691. Almost half of them (3621 patients) died of cardiac disorders. Seventy-two patients with cardiac arrest were considered for resuscitation. Finally, 62 patients due to sudden death of cardiac etiology were resuscitated by EMS personnel. Return of spontaneous circulation was achieved in 11 patients.

VF was observed in 33 (53.2%) patients. Asystole was present in 11 (17.7%) and other rhythms in 18 (29.1%) cases (Table). Patients with VF as an initial rhythm were more likely to be successfully resuscitated than patients with asystole.

More than two-thirds (67.7%) of patients with cardiac arrest were resuscitated by bystanders, and 7 (16.7%) of them survived when cardiac arrest was bystander-witnessed. Six patients were with ventricular fibrillation as initial rhythm.

The mean distance to the location of collapse of patients with VF was about 4.98 km (range 0.2–15 km); with asystole, 6.73 km (range 1–14 km); with other rhythms, 4.31 km (range 1–12 km). The mean time from call receipt to ambulance arrival to patients with VF was 5.88 min (range 1–14 min); with asystole, 6.64 min (range 3–12 min); with other rhythms, 5.72 min (range 2–11 min). The mean duration of resuscitation of patients with VF was 27.36 min (range 4–65); with asystole, 32.18 min (range 11–65); with other rhythms, 32.22 min (range 8–83).

Discussion

Improvement in the results of CPR and the subsequent quality of life of patients after cardiac arrest is one of the greatest challenges in modern medicine (6). This study is the first analysis from the city of Kaunas, which has used the Utstein template. In our study, we have introduced the simple method of reporting resuscitation events using the Utstein template that was switched on at the moment of ambulance start and continued during the whole resuscitation procedure, to admission to hospital or the death of the patient. CPR is most effective when started immediately after the victim's collapse. Organization of EMS and

Table. Baseline characteristics of patients with different cardiac rhythms

Characteristic	Ventricular fibrillation		Asystole		Other rhythms		P value
	N=33	%	N=11	%	N=18	%	
Age, mean±SE, years	61.64±2.73		55.64±6.94		64.39±2.84		0.33
Males	28	84.8	9	81.8	14	77.8	0.82
Bystanders	32	97.0	11	100	18	100	0.64
Resuscitated by bystanders	25	75.8	7	63.6	10	55.6	0.32
Effective resuscitation	9	27.3	–	–	2	11.1	0.08
Cardiac arrest location							
City	33	100	9	81.8	18	100	0.01
Public place	22	66.7	8	72.7	14	77.8	0.70
At home	10	30.3	1	9.1	4	22.2	0.35
At work	1	3.0	2*	18.2	–	–	0.07
Distance to patient, mean±SE, km	4.98±0.57		6.73±1.41		4.31±0.71		0.39
Time from dispatch to arrival, mean±SE, min	5.88±0.58		6.64±1.00		5.72±0.69		0.80
Resuscitation duration, mean±SE, min	27.36±2.45		32.18±4.11		32.22±4.78		0.59

*P<0.05 comparing patients with asystole and patients with ventricular fibrillation.

dispatch systems varies in different countries and cities. It is based on basic life support units and advanced life support units with different personnel and equipment (1). In Lithuania, the emergency medical system is based on rapidly responding basic life support and advanced life support units with physicians and/or paramedics on board, which provide advanced resuscitation and early defibrillation. The efficacy of this particular part of the chain of survival depends strongly on the competence of the dispatch center personnel. In our study, advanced cardiopulmonary resuscitation was performed in 11 patients after cardiac arrest during one year. In the analysis of 22 European cities by Herlitz *et al.* (7), the number of resuscitations attempted by respective EMS systems varied between 525 in Berlin (Germany) and 35 in Varkaus (Finland) per year. However, the incidence of out-of-hospital cardiac arrest in which resuscitation efforts were attempted per 100 000 inhabitants ranged from 34 to 63 cases. As reported in most studies, the majority of sudden cardiac arrests are of cardiac etiology (1). In present study, this etiology was confirmed in 63 (87.5%) patients.

Because rapid defibrillation is the only sufficient intervention (*i.e.*, defibrillation and only defibrillation can reverse VF cardiac arrest), it is often indicated to

be the single most important factor in determining survival from adult sudden cardiac arrest (5, 8). The Utstein style report confirmed witnessed arrest with bystander CPR and VF initial rhythm to be most effective in achieving any return of spontaneous circulation. The incidence of out-of-hospital VF has been changing during the past decade – a major decline has been observed, and these changes are likely to reflect the decline in mortality from heart disease (9). In our study, VF as an initial rhythm was found in 53.2% and pulseless ventricular tachycardia in 29.1% of cases, which seems to be consistent with the data of studies cited above.

Data from the literature indicate that defibrillation is an independent predictor of survival after cardiac arrest that occurs in out-of-hospital settings, after adjustment for ambulance response time and bystander CPR. Bystander CPR can prolong VF, consequently increases the chances of successful defibrillation, and is associated with an increased survival (10, 11).

Within 2 min of cardiac arrest, two-thirds of patients show electrocardiographically documented VF or tachycardia, but the probability of a shockable rhythm declines over time (12). Analysis of the interval between cardiac arrest and arrival of an ambulance performed in 5505 patients by Herlitz *et al.* (13) showed

that an interval longer than 5 min was inversely related to survival. In the present study, the median interval from the call to the ambulance arrival for patients with VF was 6 min (range from 1 to 14 min).

The overall outcome of out-of-hospital resuscitation in the city of Kaunas is still unsatisfactory, and the results of the present study indicate that the rate of bystander CPR should be increased and time interval between the call and defibrillation should be shortened.

Conclusions

Cardiac arrest treatment continues to evolve. Adequate treatment of the individual patient requires that all emergency system would function smoothly,

consistently, and rapidly. To maximize community-wide survival rates, a careful evaluation of the entire chain of survival is necessary, using standard measurements of performance. Electrocardiogram, one of essential diagnostic measure, shows that ventricular fibrillation was the most common electrocardiographically documented cardiac rhythm during cardiac arrest in out-of-hospital settings. Ventricular fibrillation as a mechanism of cardiac arrest was associated with major cases of successful resuscitation.

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Sėkmingo gaivinimo priklausomumas nuo elektrokardiografiškai registruoto ritmo staigios mirties atveju

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Raktažodžiai: gaivinimas, skilvelių virpėjimas, Utstein tipo standartas, staigi mirtis ikihospitaliniu laikotarpiu.

Santrauka. Darbo tikslas. Nustatyti ritmo, registruoto ikihospitaliniu laikotarpiu staigios širdinės kilmės mirties atveju, įtaką sėkmingam gaivinimui.

Darbo metodai. Studija atlikta Kauno mieste, turinčiame 360 627 gyventojų. Per metus registruota 6 691 mirtis nuo išeminės širdies ligos. Greitoji medicinos pagalba buvo kviesta 72 pacientams. Iš jų 10 pacientų staigi mirtis konstatuota ne nuo širdies ligų (trauma, apsinuodijimas, uždusimas). Dėl širdinės kilmės staigios mirties buvo gaivinti 62 pacientai. Duomenys įvertinti vadovaujantis tarptautiniu Utstein tipo standartu, skirtu tokiems atvejams analizuoti.

Rezultatai. Tarp 62 pacientų, kurie buvo gaivinti greitosios medicinos pagalbos personalo, skilvelių virpėjimas nustatytas 33 (53,2 proc.) pacientams. Asistolija – 11 (17,7 proc.), kitas ritmas nustatytas 18 (29,1 proc.) pacientų. Vertinant atgaivintus pacientus, konstatuota, jog patyrę skilvelių virpėjimą pacientai buvo atgaivinami dažniau ($p=0,047$).

Išvada. Staigios mirties, ištiktos Kauno mieste ikihospitaliniu laikotarpiu, atvejais, greitosios medicinos pagalbos tarnyba gaivinimo metu dažniau registravo skilvelių virpėjimą nei kitus ritmus (asistolija ar elektro-mechaninę disociaciją), o tokie pacientai būdavo dažniau atgaivinami nei kitų ritmų sutrikimų atvejais.

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