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The efficacy of cardiopulmonary resuscitation, in a large city, based on Krakow's Emergency Medical Service

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Abstract: **I n t r o d u c t i o n:** For many years, one of the biggest challenges of public healthcare system, in the European Union are cardiovascular diseases.

P u r p o s e: The purpose of this study was to analyze the variables influencing the specific aspects of the chain of survival in a large city.

M e t h o d s: Patients included in this study had to fulfill all of the following criteria: (1) patient had to experience an out-of-hospital cardiac arrest (OHCA), (2) emergency medical team had to initiate cardiopulmonary resuscitation (CPR) at the site of the event. Data were collected from the 1st of January to the 31st of December 2004.

R e s u l t: In a time period from the 1st of January to the 31st of December 2004 emergency medical teams initiated 381 resuscitations. The incidence of OHCA in which CRP was initiated was 50 events / 100 000 inhabitants. Spontaneous circulation was achieved in 163 patients (42.8%). Thirty-day after the resuscitation 62 patients (16.3%) were alive, and 52 patients (13.6%) were discharged alive from the hospital.

C o n c l u s i o n s: Analysis of collected data shows that return of spontaneous circulation (ROSC) was achieved in 42.8% of patients, 16.3% survived at least 30 days following the event, and 13.6% of patients were discharged alive from the hospital. These results are similar to findings from different studies conducted in Poland.

Keywords: cardiopulmonary resuscitation, Utstein protocol, return of spontaneous circulation.

Introduction

For many years one of the main concerns of a public health care system in European Union (EU) are cardiovascular diseases. Despite the fact that in the last decade there is a decrease in mortality rate due to cardiovascular problems, it still remains the leading cause of death in the EU, and it is even more visible in Poland. The mortality rate was 635.3 in Poland and 383.4 per 100,000 habitants in the UE in 2013 [1]. This also has its impact on increase in number of sudden cardiac arrest. Unfortunately, the survival rate after sudden cardiac arrest is still low, and because of that it is imperative to find a way to improve the outcomes of the cardiopulmonary resuscitation (CPR). Identification of the specific factors which are the weakest points of the chain of survival, and improvement of them, can lead to significant increase in survival rate as well as improvement in the quality of life of the patients.

The purpose of this study was to analyze the factors which have influence on survival following out-of-hospital cardiac arrest (OHCA) in a big city, and development of a plan of action which would lead to increase in success of the resuscitation effort. Currently there are very few studies, based in Poland, concerning this problem. Majority of them is focused on pre-hospital period. This study is a first study based on a Krakow population which includes data about survival of a hospital stay and the discharge from the hospital.

Materials and Methods

Inclusion criteria: all patients who experienced OHCA and the resuscitation effort was initiated by the emergency medicine team at the site of the event. Data were collected from the 1st of January till the 31st of December 2013 in the city of Krakow. Data were collected based on medical documentation collected by Krakow Emergency Medical Service, and 10 hospitals in Krakow, where patients were admitted following the OHCA events. All analyzed data regarding the time period necessary for an arrival of an ambulance were based on dispatchers' record and the personnel of emergency medical system in Krakow.

In Krakow, in year 2004, were active 21 emergency medicine teams, 9 staffed by Paramedic only and 12 with doctor on board. The infrastructure of the city was 326.85 km² with approximately 757,000 residents [2].

The study was conducted after receiving a permission from a biomedical board of Jagiellonian University. The results were analyzed according to Utstein protocol regarding out of hospital cardiac arrest [3]. Statistical analysis of collected data was performed using MS Excel and STATISTICA (version 9.0). The data are presented as mean, median and a standard deviation. For analysis of correlation between unsuccessful resuscitation effort and other measured variables a chi- squared test was used.

Results

In the time period from 1st of January till the 31st of December of 2004 there were 381 resuscitation performed by emergency medical teams in Krakow. The frequency of OHCA in which ambulance crew attempted resuscitation was 50 cases per 100,000 residents. Return of spontaneous circulation (ROSC) was achieved in 163 patients (42.8%). 30-day survival after the sudden cardiac arrest was seen among 62 patients (16.3%) and 52 (13.6%) patients were discharged from the hospital. The mean time of response of the emergency team, measured from contact with a dispatcher, was 8 minutes 22 seconds and the median was 7 minutes. Data regarding specific reasons of sudden cardiac arrests seen in analyzed population are presented in Table 1 and 2.

Table 1. Demographical data.

Gender	Men	Women
	67.2%	32.8%
Age (average / median)	62.6 (Me = 65)	

Table 2. OHCA general data.

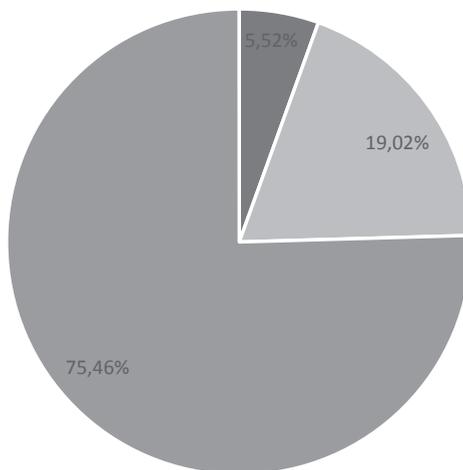
Place of OHCA	Home — 64.3% (n = 245) Street — 24.1% (n = 92) Public place — 11.6% (n = 44)
Witness OHCA	Yes — 46.8% (n = 178) No — 39.5% (n = 150) Witness by medical staff — 13.7% (n = 52)
Bystander CPR	Yes — 22.1% (n = 84) No — 64.2% (n = 244) Witness by medical staff — 13.7% (n = 52)
First recorded rhythm	VF/VT — 43.7% (n = 97) Asystole — 43.2% (n = 96) PEA — 13.1% (n = 29)

The correlation between the variables presented in Table 2 and success of the resuscitation effort, as well as 30-day survival following the sudden cardiac arrest, are presented in Table 3.

All 163 patients following ROSC were brought to a hospital. The patient's conditions at the arrival are presented in Figure 1. Patients who were conscious at the admission to a hospital were almost twice as likely to be discharged from the hospital comparing to unconscious patients following ROSC (55.6% vs. 30.9%; $p < 0.002$).

Table 3. Analysis of variables affecting the effectiveness of resuscitation.

	ROSC	P	30-day survival	P
Time of arrival 0–8 min	109 (46%)	0.2144	47 (19.9%)	0.005
Time of arrival above 8 min	50 (36.2%)		12 (8.8%)	
Witnessed cardiac arrest — Yes	117 (50.9%)	0.0001	46 (20%)	0.016
Witnessed cardiac arrest — No	46 (30.7%)		16 (10.7%)	
Bystander CPR — Yes	71 (52.2%)	0.006	31 (22.8%)	0.011
Bystander CPR — No	92 (37.7%)		31 (12.7%)	
First recorded rhythm — shockable	74 (76.3%)	0.0000	35 (36.1%)	0.000
First recorded rhythm — non-shockable	48 (38.4%)		12 (9.6%)	
Cardiac arrest at home	93 (38.0%)	0.05	30 (12.2%)	0.019
Cardiac arrest at street or public place	70 (51.5%)		32 (23.5%)	



ROSC just pulse
 ROSC pulse and breathing
 ROSC consciousness regained

Fig. 1. Patient status at the time of arrival at the hospital.

Discussion

In this study, almost 20 variables were analyzed, but only 8 of them were statistically significant and has a measurable influence on success of the resuscitation efforts. Those variables are: age of a patient, presence of a bystander, time period for arrival of the ambulance and initiation of CPR, the cause of sudden cardiac arrest, use of defibrillation by the emergency medical team, and presence of consciousness of the patient during the hospital admission following the ROSC. From those variables only the age of a patients is an unmodifiable variable, and this indicated that success of the resuscitation can be positively influenced by changes in emergency response system and education of a communities focusing on improvement of the above aspects.

Data analyzed were divided into 3 time periods: (1) pre-hospital (ROSC), (2) 30 days from the admission following the sudden cardiac arrest and (3) time period to the discharge from a hospital following sudden cardiac arrest. Data regarding ROSC in this study is worse comparing to data published based on Krakow emergency response system from 2000–2001 (50.15%) [4]. However, the condition of patients following the ROSC was much better. This study had lower percentage of patients among whom only spontaneous circulation was achieved (from almost 80% to 75.5%), and there was a higher percentage of patients among whom all basic life functions were achieved including normal level of consciousness (from 2% to 5.5%). Data regarding patients' condition, presence of consciousness, during an admission to a hospital are statistically significant and indicate two times decrease in a risk of death of a patient. Data regarding ROSC in other countries fall in a wide range from 7–61% [5–7] similarly in Poland studies show wide range from 27 to 71% [8–12] (Table 4).

Table 4. ROSC in Polish studies.

Author	Town	Time period	ROSC
[8]	Inowrocław	2000–2001	74%
[9]	Elbląg	2002–2004	55.38%
[10]	Łódź	2004–2006	55%
[11]	Poznań	2006–2007	31.9%
[12]	Katowice	2001–2002	27.7%

There are very few Polish studies analyzing 30 days survival or survival till the discharge from the hospital following the sudden cardiac arrest and success of resuscitation in those studies falls between 5–7% [13, 14].

In our study the percentage of patients who were discharged from the hospital is similar to studies based on a population of Inowrocław, however it is higher than

data presented in the studies based on Katowice [12] or Skierniewice [15] (Tab. 5). In numerous publication for other countries the percentage of survival of patients during this time period is between 2–31% [6, 7, 16].

Table 5. Cardiac arrest 30-day survival or survival to hospital discharge in Polish studies.

Author	Town	Time period	Survival rate
[9]	Elbląg	2002–2004	21%
[8]	Inowrocław	2000–2001	17.4%
[12]	Katowice	2001–2002	9.0%
[15]	Skierniewice	2006	4.1%

The crucial part determining the success of resuscitation is time. It has influence on every part of the chain of survival [2]. Both, early recognition of risk of death, calling for help, implementation of basic life support, early defibrillation, as well as initiation of advanced life support as soon as possible has an imperative value in successful resuscitation. The time of arrival of an ambulance, as well as, education of the society about the necessity of immediate contact with emergency system and initiation of a basic life support, including a use of AED, when they witness initial signs of cardiovascular collapse.

It is common that emergency system is notified when the first signs of cardiovascular collapse are present, meaning before the sudden cardiac arrest occurs, and thank to that the time form cardiac arrest to arrival of an ambulance is much shorter and the patient has higher chances of survival. Shorter time of arrival is seen in small cities in Poland [4, 9, 11, 12, 15, 17] (Table 6). In studies conducted in other countries the mean time for arrival is between 4–10 minutes [5, 6, 13, 18].

Table 6. Time of arrival in different Polish studies.

Author	Town	Time period	Time of arrival
[4]	Biała Podlaska	2000–2001	4 min. (median) 4 min. 19 sec. (average)
[15]	Skierniewice	2005–2006	5 min. (median) 8 min. 49 sec. (average)
[9]	Elbląg	2002–2004	6 min. 25 sec. (average)
[11]	Poznań	2006–2007	6 min. (median)
[12]	Katowice	2001–2002	7 min. (median)
[18]	Polish Resuscitation Council Cardiac Arrest Registry	2013–2014	9 min. (median)

Another important aspect of a successful resuscitation is presence of bystanders when the cardiovascular collapse occurred. Presence of bystanders leads to faster notification of emergency response system and increases the chances of initiation of CPR before the arrival of an ambulance. The presence of bystanders is more common if cardiovascular collapse happens in a public place. Initiation of resuscitation efforts by bystanders before the arrival of an ambulance leads to doubling the chances of survival of a patient until the discharge from a hospital [19].

In this study, a percentage of events in which bystanders initiated CPR was low. It was estimated, that in order to achieve a significant reduction in mortality due to cardiovascular collapse at least 20% of population needs to be trained in BLS [20]. In Poland it is still uncommon to initiate CPR before an arrival of an ambulance, between 10–20% [8, 10–12] (Tab. 7). In Sweden from the year 1989 approximately 2 million of people were trained in BLS and this lead to increase in initiations of BLS by bystanders from 31% in 1992 to 55% in 2007 [21].

Table 7. Bystander CPR in different Polish studies.

Author	Town	Time period	Bystander CPR
[11]	Poznań	2006–2007	19.8%
[8]	Inowrocław	2000–2001	14.4%
[12]	Katowice	2001–2002	11.2%
[10]	Łódź	2004–2006	10.3%

A further increase in frequency of attempting a cardiopulmonary resuscitation by bystanders is possible due to implementing basic life support skills education in public schools. This change is possible due to a new law regarding National Emergency Medicine system, which obliged minister of Education to implement it. As a result, a new class, education for safety, was introduced for kids attending junior high school. Some of the aspects discussed in this subject are: safety of the scene of an accident, calling for help, recognizing the level of consciousness, placement of a patient in a safe position, and performance of a cardiopulmonary resuscitation. The effects of educating kids about how to initiate first aid to a victim will be seen in the next few years, which will most likely lead to increase in frequency of cardiovascular resuscitation by bystanders. Although it is important to remember about providing schools with necessary educational aids such as phantoms, as well as maintenance of high quality of education, only then, positive outcomes of the new system will be observed.

Another factor which has a significant influence on the success of resuscitation is timely use of defibrillation. Use of defibrillator in the first minutes, following a witnessed cardiac arrest, leads to a survival rate of 70–90%. Almost half of a patients

who suffered from ventricular fibrillation, among whom within 4–5 min. from the occurrence of fibrillation an CPR and defibrillation was performed has a chance for survival in a good condition. If this time is prolonged to 8–10 min., only about 5–6% of patient will have a return of normal psychomotor and higher association center functioning which allow for a normal life [22].

A much higher chance of survival was observed among patients whose first monitored rhythm was VF/VT and among whom a defibrillation was performed. This is why it is imperative to initiate actions, in which the time necessary for the first defibrillation would be shortened, meaning decreasing the time period in which patients is in those rhythms. The second aspect depends on shortening a time period necessary for initiation of cardiopulmonary resuscitation, which is associated with ability of bystanders to perform BLS. Also, minimization of time period necessary for a defibrillation could be achieved by spread of knowledge about Public Access Defibrillation (PAD) and providing police cars with AED.

PAD programs were implemented in 11 from 36 countries which took part in European AED study [23]. After placement of defibrillators in public places in Austria, survival of patient following OHCA increased from 4.3% to 27%. The time period necessary for performing first discharge was 3 minutes 30 second [22]. In England in years 2000–2002 six hundred eighty one AED were placed in 110 public locations. The time period necessary for first defibrillation after a cardiac arrest was in most cases between 3–5 minutes. Ventricular fibrillation was observed in 82% of patients and 25% survived until a discharge from a hospital [24].

Conclusions

1. In year 2004 in Krakow sudden cardiac arrest was observed more commonly among men. The mean age of patients was 62.6 years. The frequency of OHCA was 50 events/100,000 habitants.
2. The mean time necessary for arrival of the team to a site of the event was 8 minutes 22 second. The median time was 7 minutes.
3. In analyzed data the percentage of achieved ROSC was 42.8%, 16.3% survived 30 days following the event and 13.6% of patients was discharged from the hospital. These results are comparable to results published based on other populations in Poland.
4. The analysis of data indicates that shorter time period necessary for an arrival of an ambulance, presence of bystanders at the site of the event, initiation of a CRP by bystanders before the arrival of a resuscitation team, presence of a shockable rhythm during the first analysis lead to higher survival rate, measured by both ROSC as well as survival 30 days following the event.

5. Patients following the OHCA, who were conscious at the admission to the hospital, comparing to unconscious patients following ROSC, were almost twice as likely to survive and to be discharged home (55.6% vs 30.9; $p < 0,002$).

Conflict of interest

None declared.

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