

Out-of-hospital cardiac arrest (OHCA) Survey in Lombardy: data analysis through prospective short time period assessment

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Summary. *Background and aim of the work:* The results of out-of-hospital cardiac arrests (OHCA) are usually reported through data collected collected via "ad hoc" registries, but in large populations, samples of short time periods can be used to apply the results to the entire population. We would like to describe the situation of Lombardy to provide evidence on successful procedures, which may be carried out in a larger context. *Methods:* Observational, prospective, analytical, single cohort study in Lombardy population. Data of OHCA of cardiac aetiology, according to "Utstein Style", with resuscitation attempts started by the Emergency Medical Service (EMS), were collected for 40 days subdivided in 10-day-periods in all seasons 2014-15 via Operating System "Emergency Management" (EmMa). *Results:* Of 1219 cases, 536 events of witnessed OHCA of presumed cardiac etiology were analyzed. Outcomes were: sustained Return Of Spontaneous Circulation ROSC (25.6%), Survival Event in Emergency Department (22.8%), Survival after 24 hours (21.2%) and Survival after hospital discharge at home 30 days after (11.2%). Statistically significant results were found in age, rhythm of presentation, and resuscitation by bystanders. Sex, seasonality and rescue timing did not differ statistically. *Conclusions:* Overall the thirty-day survival rate was similar to studies with larger databases. Our data are consistent with the concept that all emergency service should provide CPR instructions for every citizen who activate the EMS in the suspect of a SCA; further investigation should clarify how long interval could be useful for ROSC and sustained ROSC in patients resuscitated by lay people using CPR instructions. (www.actabiomedica.it)

Key words: Resuscitation, OHCA, EMS, Utstein Style, Lay Persons, bystanders-CPR, ROSC, sustained ROSC

Glossary

Azienda Regionale Emergenza Urgenza, (Emergency Medical System Regional Trust): AREU
Advanced Life Support (ALS)
Out-of-hospital cardiac arrest: OHCA
Sudden Cardiac Arrest: SCA
Emergency Medical Service: EMS
Return Of Spontaneous Circulation: ROSC
Cardiopulmonary Resuscitation: CPR
Automated external defibrillator: AED

Medical Emergency Dispatch Centers: MEDC
Emergency Department: ED
Italian National Institute of Statistics: ISTAT
Joints Territorial Systems: JTS
Cerebral Performance Categories: CPC
Intensive Care Unit: ICU
Cardiac/Coronary Care Unit: CCU
Ventricular fibrillation: VF
Public Safety Answering Points: PSAPs

Introduction

Survival from out-of-hospital cardiac arrest (OHCA) is closely related to the application of the maneuvers detailed in the four links of the “Chain of Survival” (1,2), where bystander Cardiopulmonary Resuscitation (CPR) and early defibrillation are synergic with the interventions performed by the Emergency Medical System (EMS).

The restoration of spontaneous cardiac function is closely related to an early recognition of the sudden cardiac arrest (SCA) condition by those who can witness the event and immediately begin chest compression, and by an early defibrillation in presence of a shockable rhythm (3). Early defibrillation also depends on the prompt availability of an Automated External Defibrillator (AED), which requires their diffusion in public places to increase the likelihood of immediate availability (4-7).

Systematic data on SCA in our country are scarce and limited to earlier investigations (8,9) and a few more recent studies (10). All these studies identified a prevalence of approximately 1000 SCA per year per million of inhabitants. These results were obtained with data collected through registries, reporting the exact number of events; the following data acquisition was then feasible thanks to some co-investigation reviewing each case and following them during hospital-stay and after discharge. The relatively limited number of events and hospitals in those areas were important elements affecting the study design and subsequent results.

Lombardy is the most populated Italian region with a resident population of approximately 10 million people. According to previous estimates SCA incidence accounts for approximately ten thousand events/year.

A complete reorganization of EMS took place in recent years, with the introduction of the European Unique Emergency Number 112, the reduction of the Medical Emergency Dispatch Centers (MEDC) (from twelve to four Operative Centers covering more provincial territories), the re-organization of emergency calls and vehicles delivery. Only after accomplishment of these tasks, it was possible to acquire regional data in a more uniform way also thanks to a brand-new

technology linking together the four MEDC and facilitated a more homogeneous data acquisition. Closer relationships between operators involved in the out-of-hospital (OH) setting or in the in-hospital services offered the opportunity to follow the patients till the hospital discharge, at least in the major hospital facilities.

We recognized that previous data in Lombardy were collected only in very small areas, and referred to only the OH setting until the arrival at the Emergency Department (ED). There was no information on outcome following hospital admission. We realized that the new uniform system would offer the opportunity of a more complete data recording in the entire region. We are convinced that the promotion of awareness of all operators should begin by improving the data acquisition.

Materials and methods

The study population included all residents in Lombardy, estimated 9924447 people in 2013 according to the Italian National Institute of Statistics (ISTAT). The territory covered by AREU, Azienda Regionale Emergenza Urgenza, Regional EMS Trust in Lombardy taking care of Emergency and Urgency, is estimated at 23861 square kilometers, 1544 municipalities distributed in 12 provinces. The management of the interventions includes 12 provincial Joints Territorial Systems (JTS) and 4 regional Medical Emergency Dispatch Centers (MEDC), with the purpose of coordinating every ambulance or advanced rescue vehicle (cars and helicopters).

Territorial rescue is ensured by 265 ambulances (with 2-3 rescuers that are qualified to perform Basic Life Support maneuvers only), 50 Intermediate Rescue Vehicles with a nurse on ambulance or car, 59 Advanced Rescue Vehicles with a physician certified to perform Advanced Life Support (ALS) and 5 helicopters with ALS crew members. All operators were sensitized through their chiefs of services to register every case of SCA. Some operators of the MEDC personnel were also identified to follow the patients admitted to the hospitals to follow up until the 30th day after hospital discharge.

Data were prospectively collected over four 10-day periods, each one representing a season, all starting on Monday, for a total of 40 days: from 14th to 23rd October 2013 (Autumn), 14th to 23rd January 2014 (Winter), 14th to 23rd March 2014 (Spring) and from 14th to 23rd July 2014 (Summer). The data were extrapolated from the regional database and built by the information of the records of the operators of territorial EMS. Whenever missing, data were requested to the physician of the MEDC.

The data, reported according to the Utstein Style, refer to SCA of presumed cardiac origin (11,12). The exclusion criteria were: undiagnosed OHCA, unwitnessed OHCA, events where cardiopulmonary resuscitation (CPR) by EMS was not attempted for injuries incompatible with life (as beheading, charring, etc.) or for the body conditions such as hypostatic stains, “rigor mortis”, etc.

We considered sustained Return Of Spontaneous Circulation (ROSC) as defined by the maintenance of perfusing spontaneous cardiac activity lasting longer than 20 minutes.

Patients with sustained ROSC were transported to the most appropriate hospital. In case of non-return of spontaneous circulation, patients were declared deceased on site. In case of patients transported with ongoing CPR, the outcome was evaluated on arrival at the ED.

For the assessment of “outcome” the “Survival Event” was used for the following time intervals: sustained ROSC on-site, survival at arrival in the emergency room, survival after 24 hours, survival at hospital discharge and at home at 30 days after the cardiac event. In those survivors at 30 days, neurological conditions were determined by the “Cerebral Performance Categories” (CPC) scale (CPC 1-2 good neurological performance, CPC 3-4 compromised neurological performance).

Age, sex, time intervals (emergency call-to-target), bystander resuscitation (CPR or chest compression only), use of an Automated External Defibrillator - AED), presenting rhythms (by either an AED or an EMS monitor-defibrillator), seasons were also investigated.

Non-ROSC patients were used as comparative group. Frequencies were analyzed by the chi-square

test with contingency tables. A p-value less than 0.05 was considered statistically significant. Statistical analysis was carried out with the “Statistical Package for Social Science” (SPSS).

Results

A total of 1219 OHCA were collected, corresponding to an incidence of about 1000 SCAs per 1000000 inhabitants every year (1: 1000/year).

Among these, resuscitation maneuvers were started by the EMS personnel in 854 patients (70.1%), while in the remaining 365 (29.9%) CPR was not initiated.

A presumed cardiac etiology was attributed to 762 cases of the 854 patients (89.2%) while in 92 cases (10.8%), SCA was attributed to non-cardiac causes. The presence of witness lay people occurred in 439 (57.6%) whereas in 97 patients SCA occurred in presence of EMS personnel (12.7%) accounting for a total of 536 cases (70.3% of the total) (Fig. 1).

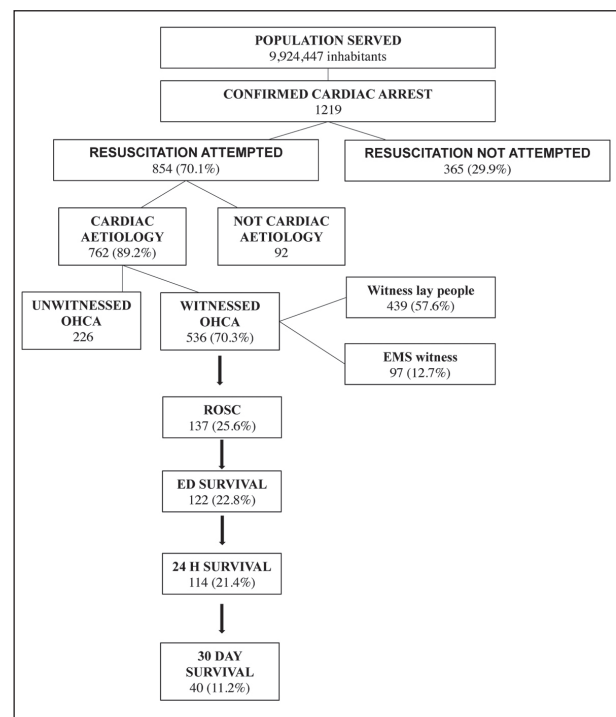


Figure 1. Utstein template of Lombardy's OHCA
Legend: OHCA: Out of Hospital Cardiac Arrest; ROSC: Return Of Spontaneous Circulation; ED: Emergency Department

Of the 536 presumed cardiac etiology arrests witnessed by bystanders there were 320 males (59.7%), mean age 71 years, and 196 females (36.6%), mean age 78 years; sustained ROSC was obtained in 137 cases (25.6%), survival at ED arrival occurred in 122 cases (22.8%) and survival at 24 hours regarded 114 patients (21.2%). Hospital discharge occurred in 40 patients (11.2%) and was coincident with survival at 30 days at home. In this group of patients, the neurological outcome highlighted a CPC 1-2 in 36 cases (6.7%) and a CPC 3-4 in 18 cases (3.3%).

A comparison between ROSC vs non-ROSC patients related to presenting rhythms, call-to-target time intervals, bystanders-CPR, use of public AED and numbers of events in relationship to the periods is reported in Table 1.

In patients in whom the first rhythm was shockable the mean interval was 9.5 minutes (range: 3'- 25'), while in the non-shockable rhythms it was 11 minutes (range: 4'- 32').

Before EMS arrival, CPR was started in 162 cases (30%) and the use of an AED in 10 cases (1.8%). In the 162 patients in which CPR maneuvers were begun by bystanders, ROSC was observed in 52 patients (32.1%), whereas in the 374 in which the CPR interventions were performed only after EMS arrival the survival occurred in 85 patients (22.7%) (Table 2).

One-hundred patients experienced a shockable rhythm (18.7%) as presenting rhythm, while in 312

Table 2. Outcome's analysis in patients with and without bystander CPR (p value 0.022)

	ROSC	non-ROSC
Bystander CPR, No./162 (%)	52 (32.1%)	110 (67.9%)
No bystander CPR, No./374 (%)	85 (22.0%)	289 (78.0%)

Legend: ROSC: Return Of Spontaneous Circulation; CPR: Cardiopulmonary Resuscitation

cases the rhythm was non shockable (58.2%) (Table 1). In the 10 patients in whom an AED was used by lay people a shockable rhythm was detected in 3 patients while 2 had a non-shockable rhythm and in 5 it was unknown.

Defibrillating and non-defibrillating rhythms in relationship to time intervals are described in Fig. 2.

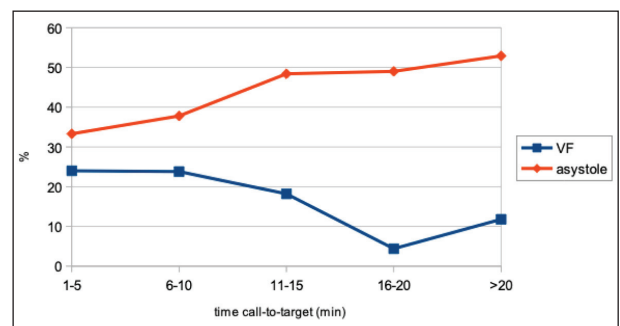


Figure 2. Correlation between defibrillating and non-defibrillating rhythms, and time intervals

Legend: VF: Ventricular Fibrillation

Table 1. Statistical validity of the variables when comparing patients characterized by Return Of Spontaneous Circulation (ROSC) vs non-ROSC patients

	ROSC No./137 (%)	Non-ROSC No./399 (%)	P-value
VF/pulseless VT	56 (40.9)	44 (11.0)	< 0.001
PEA/asystole	51 (37.2)	261 (65.4)	< 0.001
Age	65,3 ± 18	76 ± 14	< 0.001
Male sex	91 (66.4)	229 (57.4)	0.079
Time call-to-target (min)	10.6 ± 4.0	11.4 ± 4.0	0.045
Bystander CPR	52 (38.0)	110 (27.6)	0.030
Use of public-access AED	4 (2.9)	6 (1.5)	0.490
October	37 (27.0)	94 (23.6)	0.487
January	38 (27.7)	116 (29.1)	0.850
March	32 (23.3)	111 (27.8)	0.364
July	30 (21.9)	78 (19.5)	0.640

Legend: ROSC: Return Of Spontaneous Circulation; VF: Ventricular Fibrillation; pulseless VT: pulseless Ventricular Tachycardia; PEA: Pulseless Electrical Activity; CPR: Cardiopulmonary Resuscitation; AED: Automated External Defibrillator

Of the 162 patients rescued by bystanders 44 (27.1%) had a shockable rhythm and 87 (53.7%) had a non-shockable rhythm, while in the remaining 31 (19.2%) the pace was unknown.

Regarding the 374 patients not rescued by bystanders a shockable rhythm was documented in 56 (14.9%), whereas in 225 (60.2%) the rhythm was non shockable; in the remaining 93 (24.9%) the pace was not detected.

Discussion

Worldwide survival after SCA remains poor despite 50 years of continuing efforts to spread the CPR maneuvers to large proportions of population (10,13-16).

The concept of the Chain of Survival introduced in 1992 has maintained his validity. Prompt EMS service activation, early beginning of CPR and early defibrillation are of paramount importance to improve survival.

Our regional EMS service in Lombardy Region has striven to improve the response to SCA situations not only through a wide training campaign among the population, also through an improvement of the whole service in terms of implementation of rescue means on the territory, AED located in every emergency ambulance and a continuous rescuer re-training. We therefore aimed to measure the effects of both EMS effectiveness in the CPR setting and the effects of CPR intervention started by lay people.

According to the Utstein Style (11,12) we considered only presumed cardiac etiology.

The importance of the bystander-CPR is widely recognized (17). We could confirm their relevance as almost 33% of patients had a ROSC, in contrast to the 22% who had ROSC when the first intervention was performed only after EMS arrival. Results are coherent with the widely recognized importance of early CPR.

Among the 107 patients who had a sustained ROSC on the spot, almost 90% were successfully admitted to the ED and more than 80% were then admitted to the ward (either ICU or CCU) in almost all instances. Only half of the patients admitted to

the ward were successfully discharged at home, 63% of whom had a CPC of 1-2. These data support the concept that an early onset of CPR is of paramount importance to promote not only a cardiac restoration but also an intact neurological function. To achieve this goal our regional dispatch centers are instructing every person who witnesses a SCA to start chest compressions, guided by the dispatch operators.

A shockable rhythm was found in 19% of the cases. This proportion is consistent with an increasing evidence that ventricular fibrillation is no longer the most frequent rhythm detected in SCA patients, in part explained by the progression of SCA in which a Ventricular fibrillation (VF) rhythm evolves toward an asystole within few minutes. This fact would be supported by the time elapsed in defibrillating and non-defibrillating rhythms (18), in which the higher proportion of non-defibrillating rhythms was observed in the group of patients who had a longer (although non-significant) time interval until the EMS arrival. On the other hand, the changes in the epidemiology of ventricular fibrillation may be accounted by the interventions on myocardial ischemia which are likely to have reduced the proportion of ischemic events, as reported in a previous publication (9).

This fact would be coherent with the observations of other several studies who consistently reported a diminished proportion of VF in their studies on SCA (8,19-22).

In the present survey we could realize that only 7 witnesses were able to use a public AED thus accounting for a very low proportion of public AED use. Our data are consistent with other studies in which the use of a public AED is very limited since it accounts for a proportion of 2.2% of people defibrillated with a public AED. The limited number of our observations does not allow us to draw conclusions although it is evident that where the public AED were used early survival was much higher raising up to 65% (4-7).

We also decided to investigate possible effects of the season on survival, not finding any evidence in the literature. Our data however did not allow us to identify specific relationships between the SCA event and the season.

Anyway, this study has some evident limitations.

First of all, it was limited to short distinct time

periods unlike the majority of the investigations which report longer periods of observation (10,13,14). However, the proportion of cases approximates the prevalence of SCA in other studies.

Secondly the quality of CPR by the witnesses could not be assessed. Nevertheless, it is likely that these maneuvers, although imprecise, may have determined some cardiac perfusion as the proportion of ROSC in this group of patients was significantly higher than those that not experienced bystander CPR.

It is widely recognized that telephone CPR instructions are associated with an increased rate of successful outcome (23,24). A study by Sutter and coworkers conducted in USA among more than 5600 Public Safety Answering Points (PSAPs), to identify those who provide telephone CPR (T-CPR) instructions, highlighted that nearly half of the nation's PSAP does not provide T-CPR and very few provide compression-only instructions. Despite the number of PSAP involved, there are no data to ascertain whether T-CPR was associated with an increased proportion of successful outcome (25).

Another limitation is related to the proportion of unknown rhythms even when a defibrillator was used. Despite the improvement in data collection, this result implies that data recording is as yet suboptimal and therefore a progressive sensitization of the personnel is necessary. This is indeed an area of improvement for our EMS personnel.

Conclusions

We suggest that short time periods of data acquisition for cardiac arrest patients may be useful to extrapolate data for the entire cardiac arrest population. The feasibility of a sample analysis is a strength that should be highlighted and applied to our advantage. These data can be useful for monitoring the events and further develop new strategies to improve their management. The ultimate goal in the study design, however, is to accomplish the requirements of the registries with full recording of all cardiac arrest data together with a close collaboration with those who work in the hospital setting to obtain the follow-up after hospital admission.

Our data support the importance of an early as possible treatment by lay people who witness a cardiac arrest and are consistent with the concept that all emergency services should provide CPR instructions for every citizen who activate the EMS in the suspect of a cardiac arrest.

Despite discussion's limitations, we emphasize the importance of an early treatment as possible by lay people who witness a SCA. Yet our data are consistent with the concept that all emergency service should provide CPR instructions for every citizen who activate the Emergency Medical Service in the suspect of a SCA.

Besides that, these data further investigation should verify the time interval from the arrest to the EMS arrival to clarify how long interval could be useful to have ROSC and a sustained ROSC in the patient resuscitated by lay people using CPR instructions.

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Conflict of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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