

FACTORS AFFECTING A SUCCESSFUL OUT-OF-HOSPITAL CARDIOPULMONARY RESUSCITATION

Anita Kalēja^{*,**#}, Kaspars Setlers^{*,***}, and Indulis Vanags^{*,**}

* Pauls Stradiņš Clinical University Hospital, Pilsoņu iela 13, Rīga, LV-1010, LATVIA;
anita.kaleja@stradini.lv

** Department of Anaesthesiology and Reanimatology, Rīga Stradiņš University, Pilsoņu 13, Rīga, LV-1010, LATVIA

*** State Emergency Medical Service of Latvia, Laktas 8, Rīga, LV-1013, LATVIA

Corresponding author

Communicated by Dainis Krieviņš

A retrospective patient record analysis of the Emergency Medical Service's Rīga City Regional Centre was provided from January 2012 through December 2013. 1359 adult patients were CPR treated for out-of-hospital cardiac arrest according to ERC Guidelines 2010. A total of 490 patients were excluded from the study. The main outcome measure was survival to hospital admission. Of 869 CPR-treated patients, 60% (n = 521) were men. The mean age of patients was 66.68 ± 15.28 years. The survival rate to hospital admission was 12.9% (n = 112). 54 of survived patients were women. Mean patient age of successful CPR was 63.22 ± 16.21 and unsuccessful CPR 67.20 ± 15.09. At least one related illness was recorded with 63.4% (n = 551) patients. There were 61 survivors in bystander witnessed OHCA and nine survivors in unwitnessed OHCA. The rate of bystander CPR when CA (cardiac arrest) was witnessed was 24.8%. Ventricular fibrillation (VF) as initial heart rhythm was significantly associated with survival to hospital admission in 54 cases (p < 0.0001). Age and gender affected return of spontaneous circulation. Survival to hospital admission had rhythm-specific outcome. Presence of OHCA witnesses improved outcome compared to bystander CPR. The objective of this study was to report patient characteristics, the role of witnesses in out-of-hospital cardiac arrest (OHCA) and outcome of adult cardiopulmonary resuscitation

Key words: cardiopulmonary resuscitation (CPR); cardiac arrest (CA); out-of-hospital cardiac arrest (OHCA).

INTRODUCTION

Despite the efforts to improve the techniques of cardiopulmonary resuscitation (CPR), a successful out-of-hospital resuscitation and patient admission to hospital with return of spontaneous circulation (ROSC) is still comparatively rare (Antwood *et al.*, 2005; Nichol *et al.*, 2008). Every five years, the European Resuscitation Council (ERC) approves new guidelines in cardiopulmonary resuscitation according to the latest scientific research results. A successful outcome of CPR depends on efforts of the emergency medical service (EMS), as well as patient-related factors, for example, age, gender, related illnesses and the initial rhythm in cardiac arrest (Herlitz *et al.*, 2005; Olasveengen, 2009). Presence of a witness and patient location during the cardiac arrest, bystander CPR and EMS response time are also important factors (McNally *et al.*, 2011; Birkenes *et al.*, 2014). However, the impact of those factors on the outcome of OHCA needs to be evaluated constantly and reliably. We focused our study on patient's age, gender, initial heart rhythm and the role of a witness in survival to hospital ad-

mission. The objective of this study was to report patient characteristics, the role of witnesses in out-of-hospital cardiac arrest (OHCA) and outcome of adult cardiopulmonary resuscitation.

MATERIALS AND METHODS

A total of 1669 patient records of the Emergency Medical Service's (EMS) Rīga City Regional Centre were collected and retrospectively analysed, in which 1359 patients were CPR-treated for out-of-hospital CA from January 2012 through December 2013. A total of 490 patients were excluded from the study — 15 younger than 18 years, 47 trauma patients, 43 patients with asphyxia as the potential cause of death and 385 patients with incomplete data. In 310 cases, there was more than one EMS team per patient attending CPR. CPR was provided according to ERC Guidelines 2010. The following data were examined: patient age and gender, related illnesses and initial heart rhythm, witnesses of cardiac arrest, EMS response time, by-

stander CPR and ROSC. A successful CPR was defined as patient admission to hospital. Data were analysed with Microsoft Excel and IBM SPSS 20. The influence of factors on a successful CPR was calculated with binary logistic regression. *P* value less than 0.05 was considered as statistically significant.

RESULTS

Of 869 CPR-treated patients included in the study, 60% (*n* = 521) were men. The average age of patients was 66.68 ± 15.28 years, with the youngest patient being 18 and the oldest 98 years of age (Fig. 1). The average ages of women were higher than those of men (71.9 and 63.1). At least one related illness was recorded with 63.4% (*n* = 551) patients. The most common related illnesses were myocardial infarction, other cardiovascular diseases (e.g. arterial hypertension, atherosclerosis) and oncology (Fig. 2). ROSC was achieved in 12.9% (*n* = 112) of all patients with attempted CPR, of which 48% (*n* = 54) were women. The mean patient age of successful CPR was 63.22 ± 16.21 and unsuccessful 67.20 ± 15.09 (Fig. 3). Of 348 women, survival to

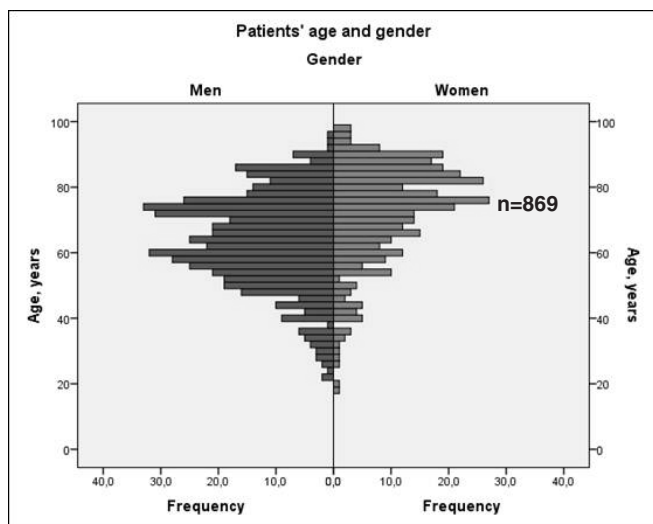


Fig. 1. Patient demographic profile regarding age and gender.

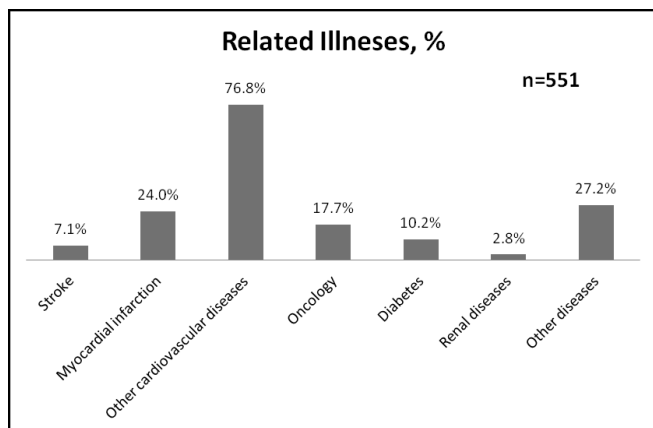


Fig. 2. Profile of frequent related illnesses. In 63.4% (*n* = 551) of all cases there was at least one related illness. Many patients had more than one related illness.

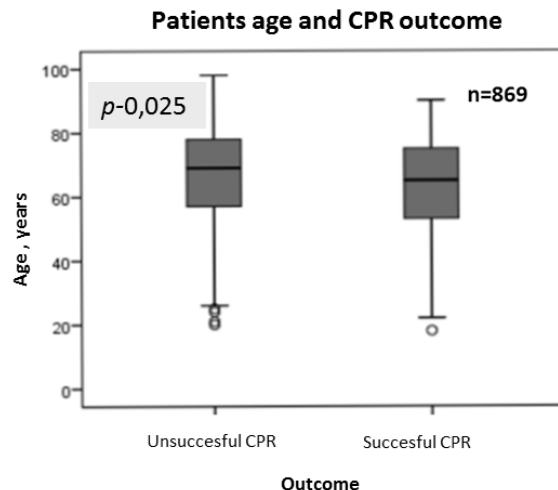


Fig. 3. CPR results in relation to patient age. 95% C.I. 0.97–0.998

hospital admission was achieved in 15.5% of cases (Table 1). There was significant difference between CPR outcome regarding patient gender (*p* = 0.007).

The most frequent first documented rhythm was pulseless electrical activity (PEA) (Table 2). Ventricular fibrillation (VF) was documented in 19.9% cases. Ventricular fibrillation and pulseless ventricular tachycardia as initial heart rhythm was associated with effective CPR in 57 cases. There was a significant difference between ROSC by VF and ROSC by PEA/Asystole (*p* < 0.0001).

Out-of-hospital cardiac arrest was witnessed by an EMS team or bystander in 720 cases and CPR was successful in 103 cases (Table 4). ROSC by unwitnessed CA was achieved in several cases (*n* = 9). Bystander CPR (including CPR attempts before EMS arrival and unwitnessed OHCA) was initiated in 22.8% cases (*n* = 132). Patients who had their cardiac arrest in the presence of bystander (Table 4) showed significantly better outcome of CPR compared to

Table 1

CPR RESULTS ACCORDING TO PATIENT GENDER

	Successful CPR*	Unsuccessful CPR	Total
Male	58 (11.1%)	463 (88.8%)	521
Female	54 (15.5%)	294 (84.4%)	348

* Patient admission to hospital with ROSC

Table 2

CPR RESULTS AND INITIAL HEART RHYTHM BY CARDIAC ARREST

	Successful CPR*	Unsuccessful CPR	Total
Asystole	6 (2.5%)	238 (97.5%)	244
Pulseless electrical activity	49 (10.8%)	402 (89.1%)	451
Pulseless ventricular tachycardia	3 (37.5%)	5 (62.5%)	8
Ventricular fibrillation	54 (32.5%)	112 (67.4%)	166

*Patient admission to hospital with ROSC

Table 3

BYSTANDER INITIATED CPR IN PATIENTS WITH CARDIAC ARREST

	Successful*	Unsuccessful
CPR was started n = 107	11 (10.3%)	96 (89.7%)
CPR was not started n = 304	47 (15.4%)	257 (84.5%)
Total survival of bystander witnessed cardiac arrest**	58	373

*Patient admission to hospital with ROSC

**Total bystander experienced cardiac arrest was 431, but in 20 cases there was no information about bystander CPR*

Table 4

CPR RESULT IN RELATION TO WITNESS OF CARDIAC ARREST

	Emergency medical service	Bystander	No one
Unsuccessful CPR	247 (85.4%)	370 (85.8%)	140 (93.9%)
Successful CPR*	42 (14.5%)	61 (14.1%)	9 (6.0%)
Total	289	431	149

*Patient admission to hospital with ROSC

patients who had unwitnessed CA ($p = 0.046$). The rate of bystander CPR attempts until an EMS team arrived was 24.8%; in 10.3% cases CPR was successful (Table 3). The impact of bystander CPR on outcome of OHCA was not significant.

The mean emergency medical service response time was 10.03 ± 4.50 min. (9.46 ± 4.07 min in successful CPR attempts). EMS response time did not have significant influence on ROSC.

DISCUSSION

This study demonstrates factors affecting return of spontaneous circulation and survival to hospital admission for patients with out-of-hospital cardiac arrest (OHCA). Survival rate by OHCA is widely variable in different studies. Survival rates after cardiac arrest worldwide are 3.6–30.7%, and in Europe approximately 9.8–10.7% of patients (Antwood *et al.*, 2005; Deakin *et al.*, 2010).

In the Cardiac Arrest Registry to Enhance Survival Study (USA), among 31 000 patients there were 26.3% positive outcomes (McNally *et al.*, 2011). In our study there were 12.9% successful resuscitations from 869 cases.

There are different definitions in different studies regarding successful resuscitation. In this study a successful CPR was defined as survival to hospital admission. In some studies successful resuscitation is defined as temporary resumption of circulation, in others — admission of the patient to hospital with resumed circulation or subsequent release of a patient from the hospital (Herlitz *et al.*, 2005; McNally *et al.*, 2011). This can lead to various interpretations of study results.

Most of all patients were men in our study (60%). The average age of women was higher than of men (71.9 and 63.1 years). This could be explained by the structure of age and gender in Latvia. Analysing those factors together (age and gender) both factors were significant and affected the outcome of CPR attempt. Our study showed that women gender and patients in age 63.22 ± 16.21 survived to hospital admission more often, which is similar to the results of other studies (Herlitz *et al.*, 2005; McNally *et al.*, 2011).

We found that in 63.4% cases there were at least one related illness. The most common were cardiovascular diseases and oncology. Common related illnesses in our study match the statistics data in Latvia (Anonymus, 2014). Impact of related illnesses to CPR outcome could be an important factor (Youngquist, 2013). We admit limitations of our study — the relationship between related illnesses and survival rate obviously existed, and needs to be examined in more detail.

We found that the rate of bystanders CPR attempts was 22.8%. In other similar studies, bystander CPR is often mentioned as one of the most important factors that can affect successful pre-hospital CPR (Bobrow *et al.*, 2010; Nordberg *et al.*, 2009). In our study there bystander CPR was not significantly related to positive outcome of CPR. Future studies are needed to better understand how to improve quality of CPR provided by lay-rescuers. Obviously, we should provide the general public with more information and basic life support (BLS) courses.

In our study, patients with witnessed OHCA survived to hospital admission in 14% cases, compared to 6% of unwitnessed OHCA patients (6%). Obviously, the presence of a witness shortens the EMS response time. The EMS response time in successful CPR attempts in our study was 9.4 min on average. This is the main factor that describes the time from cardiac arrest until CPR provided by professionals, which is variable between different countries (Vukmir, 2004; McNally *et al.*, 2011). EMS response time depends on the level of EMS system in every country and needs to be more studied in future.

The initial heart rhythm by cardiac arrest is one of the most important factors for successful resuscitation. According to the statistical data, 21.1 percent of patients with ventricular fibrillation and 10.7 percent of patients with other initial rhythms had successful outcome of CPR (Herlitz *et al.*, 2008). In our study the survival rate by VF was 32.5%.

We found that PEA was the most frequent heart rhythm by cardiac arrest. Other studies also show that non-shockable heart rhythms are more frequent than shockable (Herlitz *et al.*, 2008; McNally *et al.*, 2011). This rhythm could be following after ventricular fibrillation or the sign of effective CPR in patients with asystole. Considering the rare amount of bystander CPR, we can assume that it is possible to improve ventricular fibrillation, following defibrillation and successful resuscitation by increasing the amount of bystander CPR. Shockable heart rhythms (ventricular fibrillation and pulseless ventricular tachycardia) comparing to

other heart rhythms showed significant relationship with improved outcome of pre-hospital CPR.

REFERENCES

- Anonymous. (2014). *Statistikas dati par iedzīvotāju mirstību*. <http://www.spkc.gov.lv/veselibas-aprupes-statistika/> (accessed 2 November 2014).
- Antwood, C. Eisenberg, M. S., Herlitz, J., Rea, T. D. (2005). Incidence of EMS-treated out-of-hospital cardiac arrest in Europe. *Resuscitation*, **67**, 75–80.
- Birkenes, T. S., Myklebust, H., Neset, A., Kramer-Johansen, J. (2014). Quality of CPR performed by trained bystanders with optimized pre-arrival instructions. *Resuscitation*, **85** (1), 124–130.
- Bobrow, B. J., Spaite, D. W., Berg, R. A., Stolz, U., Sanders, A. B., Kern, K. B., Vadeboncoeur, T. F., Clark, L. L., Gallagher, J. V., Stapczynski, J. S., LoVecchio, DO; Terry J. Mullins, MBA; Will O. Humble, MPH; Gordon A. Ewy, F. (2010). Chest compression only CPR by lay rescuers and survival from out-of-hospital cardiac arrest. *J. Amer. Med. Assoc.*, **304**, 1447–1454.
- Deakin, C. D., Nolan, J. P., Soar, J., Sunde, K., Koster, R. W., Smith, G. B., Perkins, G.D. (2010). *European Resuscitation Council Guidelines for Resuscitation 2010, Section 4. Adult advanced life support*. *Resuscitation*, **82** (1), 140.
- Herlitz, J., Svensson, L., Engdahl, J., Silfverstolpe J. (2008). Characteristics and outcome in out-of hospital cardiac arrest when patients are found in a non-shockable rhythm. *Resuscitation*, **76** (1), 31–36.
- Herlitz, J., Engdahl, J., Svensson, L., Angquist, K. A., Young, M., Holmberg, S. (2005). Factors associated with an increased chance of survival among patients suffering from an out-of-hospital cardiac arrest in a nation perspective in Sweden. *Amer. Heart J.*, **149** (1), 61–66.
- McNally, B., Robb, R., Mehta, M., Vellano, K., Valderrama, A. L., Yoom, P. W., Sasson, C., Crouch, A., Bry Perez, A., Meritt, R., Kellermann, A. (2011). Out-of-Hospital Cardiac Arrest Surveillance — Cardiac Arrest Registry to Enhance Survival (CARES), United States, October 1, 2005–December 31, 2010. *Surveillance Summaries* 29 July 2011 / 60 (SS08), 1–19.
- Nichol, G., Thomas, E., Callaway, C. W., Hedges, J., Powell, J. L., Aufderheide, T. P., Rea, T., Lowe, R., Brown, T., Dreyer, J., Davis, D., Idris, A., Stiell, I. (2008). Regional variation in out-of-hospital cardiac arrest incidence and outcome. *JAMA (The Journal of the American Medical Association)*, **300**, 1423–1432.
- Nordberg, P., Hollenberg, J., Herlitz, J., Rosenqvist, M., Svensson L. (2009). Aspects on the increase in bystander CPR in Sweden and its association with outcome. *Resuscitation*, **80**, 329–33.
- Olasveengen, T. M. (2009). *Factors impacting on quality of prehospital advanced cardiac life support*. Oslo: Institute for Experimental Medical Research and Department of Anesthesiology, Oslo University Hospital.
- Vukmir, R. (2004). Survival and outcome of prehospital cardiac arrest. *Int. J. Rescue Disaster Med.*, **4** (1) DOI: 10.5580/db9.
- Youngquist, S. T. (2013). Can survival from out-of-hospital cardiac arrest be predicted from a victim's carbon emissions? *Resuscitation*, **84** (11), 1457–1458.

Received 23 August 2014

PIRMSSLIMNĪCAS ETAPA KARDIOPULMONĀLO REANIMĀCIJU REZULTĀTUS IETEKMĒJOŠIE FAKTORI

Izdzīvošana pēc kardiopulmonālās reanimācijas (KPR) joprojām ir zema, neraugoties uz medicīnas tehnoloģiju attīstību. To var ietekmēt gan pacienta faktori (vecums, dzimums, pavadslimības), gan ārējie faktori (sirdsdarbības apstāšanās liecinieki un to uzsāktie/neuzsāktie atdzīvināšanas pasākumi, Neatliekamās medicīniskās palīdzības dienesta (NMPD) ierašanās laiks). Darba mērķis bija analizēt pacientu vecuma, dzimuma, sirdsdarbības apstāšanās mehānisma un līdzcilvēku klātbūtnes un uzsāktu atdzīvināšanas pasākumu ietekmi uz KPR rezultātu. Tika retrospektīvi analizētas NMPD Rīgas reģionālā centra 1669 izsaukuma kartes no 2012. gada janvāra līdz 2013. gada decembrim. No pētījuma tika izslēgti 490 pacienti — 15 pacienti bija jaunāki par 18 gadiem, 47 traumu pacienti, 43 pacienti ar asfiksiju kā iespējamo nāves cēloni un 385 pacienti ar nepilnīgiem datiem. Tika reģistrēts dzimums, vecums, pavadslimības, iniciālais sirdsdarbības apstāšanās ritms, liecinieku klātbūtne sirdsdarbības apstāšanās brīdī, KPR uzsākšana līdz NMPD atbraukšanai, spontānās asinsrites atjaunošanās. Par veiksmīgu KPR tika uzskatīta pacienta nogādāšana slimnīcā ar atjaunotu asinsriti. Dati tika apstrādāti ar datorprogrammām *Microsoft Excel* un *IBM SPSS 20.0*. 60% no 869 pētījumā iekļautajiem pacientiem bija vīrieši. Pacientu vidējais vecums bija $66,68 \pm 15,28$ gadi. Veiksmīga KPR tika reģistrēta 112 gadījumos (12,9%), 54 no izdzīvojušajiem bija sievietes. Vidējais vecums veiksmīgo KPR gadījumos bija $63,22 \pm 16,21$. Vismaz viena pavadslimība tika reģistrēta 63,4% pacientu. Ventrikulu fibrilācija tika reģistrēta 19,9% gadījumu, asinsrites atjaunošanās notika 32,5%. Asinsrites apstāšanās liecinieku klātbūtnē reģistrēta 49,6% gadījumu ($n = 431$), izdzīvoja 61 pacients. Līdzcilvēki, kas bija klāt sirdsdarbības apstāšanās brīdī, KPR uzsāka 24,8%. Vecums un dzimums ietekmē asinsrites atjaunošanās biežumu. Sirdsdarbības apstāšanās mehānisms ietekmē KPR rezultātu. Sirdsdarbības apstāšanās liecinieku klātbūtne ietekmē KPR rezultātu vairāk kā līdzcilvēku uzsāktie atdzīvināšanas pasākumi.