Resuscitation 106 (2016) 42–48

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Admission of out-of-hospital cardiac arrest victims to a high volume cardiac arrest center is linked to improved outcome☆

Andreas Schober[a], Fritz Sterz[a,*], Anton N. Laggner[a], Michael Poppe[a], Patrick Sulzgruber[a], Elisabeth Lobmeyr[a], Philip Datler[b], Markus Keferböck[a], Sebastian Zeiner[a], Alexander Nuernberger[a], Bettina Eder[c], Georg Hinterholzer[d], Daniel Mydza[d], Barbara Enzelsberger[e], Klaus Herbich[f], Reinhard Schuster[g], Elke Koeller[h], Thomas Publig[i], Peter Smetana[j], Chrisitian Scheibenpflug[k], Günter Christ[l], Brigitte Meyer[m], Thomas Uray[a]

[a] *Department of Emergency Medicine, Medical University of Vienna, Austria*
[b] *Department of Anaesthesiology, General Intensive Care and Pain Management, Medical University of Vienna, Austria*
[c] *Municipal Ambulance Service of Vienna, Austria*
[d] *1st Medical Department, Kaiser Franz Josef Spital – SMZ Süd, Vienna, Austria*
[e] *2nd Medical Department, KA Rudolfstiftung, Vienna, Austria*
[f] *2nd Medical Department, Emergency Unit, SMZO – Donauspital, Vienna, Austria*
[g] *1st Medical Department, SMZO – Donauspital, Vienna, Austria*
[h] *3rd Medical Department, KH Hietzing, Vienna, Austria*
[i] *4th Medical Department, KH Hietzing, Vienna, Austria*
[j] *3rd Medical Department, Wilhelminenspital, Vienna, Austria*
[k] *Pediatric Intensive Care, Department of Pediatric and Adolescent Surgery, SMZO – Donauspital, Vienna, Austria*
[l] *5th Medical Department, Kaiser Franz Josef Spital – SMZ Süd, Vienna, Austria*
[m] *4th Medical Department, Kaiser Franz Josef Spital – SMZ Süd, Vienna, Austria*

ARTICLE INFO

Article history:
Received 15 March 2016
Received in revised form 31 May 2016
Accepted 20 June 2016

Keywords:
Cardiopulmonary resuscitation
Hospitals
Outcome assessment (health care)
Out-of-hospital cardiac arrest

ABSTRACT

Aim: Cardiac arrest centers have been associated with improved outcome for patients after cardiac arrest. Aim of this study was to investigate the effect on outcome depending on admission to high-, medium- or low volume centers.

Methods: Analysis from a prospective, multicenter registry for out of hospital cardiac arrest patients treated by the emergency medical service of Vienna, Austria. The frequency of cardiac arrest patients admitted per center/year (low <50; medium 50–100; high >100) was correlated to favorable outcome (30-day survival with cerebral performance category of 1 or 2).

Results: Out of 2238 patients (years 2013–2015) with emergency medical service resuscitation, 861 (32% female, age 64 (51;73) years) were admitted to 7 different centers. Favorable outcome was achieved in 267 patients (31%). Survivors were younger (58 vs. 66 years; $p < 0.001$), showed shockable initial heart rhythm more frequently (72 vs. 35%; $p < 0.001$), had shorter CPR durations (22 vs. 29 min; $p < 0.001$) and were more likely to be treated in a high frequency center (OR 1.6; CI: 1.2–2.1; $p = 0.001$).

In multivariate analysis, age below 65 years (OR 15; CI: 3.3–271.4; $p = 0.001$), shockable initial heart rhythm (OR 10.1; CI: 2.4–42.6; $p = 0.002$), immediate bystander or emergency medical service CPR (OR 11.2; CI: 1.4–93.3; $p = 0.025$) and admission to a center with a frequency of >100 OHCA patients/year (OR 5.2; CI: 1.2–21.7; $p = 0.025$) was associated with favorable outcome.

Conclusions: High frequency of post-cardiac arrest treatment in a specialized center seems to be an independent predictor for favorable outcome in an unselected population of patients after out of hospital cardiac arrest.

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2016.06.021.

* Corresponding author at: Medical University of Vienna, Department of Emergency Medicine, Waehringer Guertel 18–20/6D, 1090 Vienna, Austria.
E-mail address: fritz.sterz@meduniwien.ac.at (F. Sterz).

http://dx.doi.org/10.1016/j.resuscitation.2016.06.021
0300-9572/

Introduction

Cardiac arrest affects more than 350,000 adults in Europe every year and out of hospital cardiac arrest (OHCA) is the third leading cause of death in the USA.[1,2] Overall survival to hospital discharge in OHCA equals about 10% respectively.[2,3] Pre-hospital factors, such as good quality cardiopulmonary resuscitation and early defibrillation are already known to impact outcome after OHCA.[3,4] Despite algorithms for post-resuscitation care,[3] general cardiopulmonary intensive care and prognosis evaluation, regional differences in post-resuscitation care can be found.[5–7] Furthermore outcome seems to be influenced by geographic factors as well as the level of care of the center involved.[8–18] Not only complex therapies for a highly selected group of patients (i.e. coronary angiography for acute myocardial infarction), but a high quality post-resuscitation care, provided 24/7 seems to be beneficial.[19,20] It has been shown, similar to our own experience with intensive care units (ICUs), that the frequency of post-resuscitation care in an emergency department seems to have a positive effect on patients outcome.[21,22] Therefore the implementation of cardiac arrest centers providing a high level of specialization and a high volume of post-resuscitation-care-patients, guaranteeing a sufficient treatment frequency for the interdisciplinary team, seems to be a reasonable measure to improve patient care.[23–26] The implementation of such specialized centers has been undergone earlier in acute coronary care, stroke units, trauma- and burn injuries and consecutively in post-cardiac arrest treatment.[23,27] Recommendations have been published suggesting standards for these cardiac arrest centers,[28] but little is known about the needed minimum frequency to maintain a certain standard of care. Studies published so far, comparing regional differences and different cardiac arrest centers, focused on hospital characteristics and regional variations and were lacking detailed pre hospital data, specifically parameters concerning the course of basic- and advanced life support.

Aim of this study was to investigate a continuous, real life population admitted to different cardiac arrest centers in Vienna and their outcome depending on whether they were admitted to high-, medium-, or low volume centers. We wanted to assess the characteristics of patients admitted to different volume centers and we hypothesized that, in addition to patient demographics, resuscitation and quality of resuscitation related factors, a high annual case load is an independent predictor for neurologic intact survival.

Methods

The Vienna Cardiac Arrest Registry (VICAR) is a prospectively designed and obtained clinical, multicenter registry of patients suffering OHCA in Vienna, Austria. Data of all patients with out-of-hospital cardiac arrest with resuscitation attempts by the Municipal Emergency Medical Service (EMS) of Vienna, Austria (1.8 million inhabitants; area of 415 km^2) were obtained. The registry was founded to enable an increase in awareness of good quality CPR and provide detailed feedback to enable benchmarking for the EMS of the city of Vienna. All data were documented prospectively according to Utstein style criteria with structured protocols as reported elsewhere.[29] This study was a prospective cohort analysis based on data obtained from this registry. The study and the waiving of informed consent were approved by the Ethics Committee of the Medical University of Vienna (#:1221/2013).

All patients were treated by the Viennese two tier EMS system, which features EMS physician and paramedics, and has been previously described in detail.[30]

The collected data included demographic background information, resuscitation specific parameters according to Utstein style criteria and outcome data, such as 30-day mortality. Additionally, electrocardiogram leads, trans-thoracic impedance, as well as vital parameters (extracted from EMS defibrillators) and the use of lay AEDs were assessed. Data of EMS defibrillators (LifePak 500, 12 or 15; Physio-Control, Redmond, WA, USA) were extracted and analyzed by trained personnel. Impedance data were analyzed using CODE-STAT Reviewer (Version 8.0, Physio-Control, Redmond, WA, USA) to evaluate chest compressions, ventilations and hands-on fraction of CPR. A value "missed chest compressions" was calculated by multiplication of hands of time and recommended compression frequency and used for additional CPR quality assessment. We included time from initiation of transport to hospital admission [transport time] and time from arrival of EMS at the cardiac arrest site to admission in hospital [EMS time]. Range and consistency checks were performed to obtain valid data. In addition, we collected data regarding time intervals (from event to EMS response and on scene as well as to EMS physician on scene). Neurologic outcome was measured with use of the cerebral performance category (CPC)[31] and favorable neurological outcome was defined as CPC 1 or 2. Unfavorable neurological outcome was defined as CPC 3–5.

Patients who were consecutively admitted to a Viennese hospital for further treatment were included into the analysis. Patients who were admitted to hospitals which are not part of the ST segment elevation myocardial infarction (STEMI) network Vienna ($n = 69$) were excluded from the analysis to enable a comparison of 7 different centers, fitting the recommendation for cardiac arrest centers to have a 24/7 readily available coronary intervention facility.[32] The 8 excluded hospitals showed a case load of less than 5 cases per year respectively. All included hospitals and intensive care units provide equal standards.[33,34] Neither their technical capabilities nor the staff-to-patient-ratio differ. All are teaching hospitals with structured curriculum for training of nurses, medical students, interns and residents including one center being the university clinic of Vienna. Patients are treated in ICUs with 24/7 availability of coronary angiography and a full implantation of targeted temperature management (TTM) has been undergone according to the guidelines.[35]

The primary outcome was a combined parameter of survival for 30 days after event and good neurological performance. Analysis was performed comparing cohorts of patients admitted for post-resuscitation care to 7 cardiac arrest centers in Vienna. Patients were grouped by center frequency. Centers were divided by annual case load at <50/year for low volume, 50–100/year for medium volume and >100/year for high volume and patients were grouped into 3 cohorts consecutively. These cohorts were compared with regards to the primary outcome.

Statistical analysis

We report continuous variables as means ± standard deviation or as medians and 25–75% interquartile ranges depending on actual data distribution. Categorical variables are reported as counts and percentages. After primary analysis of data provided by our VICAR registry we plotted frequencies of each center and absolute patient numbers and grouped centers to achieve a comparable number of patients with each frequency group.

Differences between the outcome groups were assessed using Student's *t*-test and non-parametric testing for continuous variable and chi-square test for binary variables. Skewed time intervals and measurements were subject to logarithmic transformation to enable inclusion in further analysis. Data scales (peripheral oxygen saturation, CPR duration, number of missed potential chest compressions due to hands off intervals, transport time and EMS time) were grouped by quartiles to allow inclusion in logistic regression analysis. We created a combined variable, patients with either bystander CPR or EMS witnessed cardiac arrest and immediate EMS CPR [Immediate bystander and/or EMS CPR; 1 vs. 0] to correct