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Clinical paper

EuReCa ONE—27 Nations, ONE Europe, ONE Registry
A prospective one month analysis of out-of-hospital cardiac arrest outcomes in 27 countries in Europe☆

Jan-Thorsten Gräsner[a,b,*], Rolf Lefering[c], Rudolph W. Koster[d], Siobhán Masterson[e], Bernd W. Böttiger[f], Johan Herlitz[g], Jan Wnent[a,b], Ingvild B.M. Tjelmeland[h], Fernando Rosell Ortiz[i], Holger Maurer[j], Michael Baubin[k], Pierre Mols[l], Irzal Hadžibegović[m], Marios Ioannides[n], Roman Škulec[o], Mads Wissenberg[p], Ari Salo[q], Hervé Hubert[r], Nikolaos I. Nikolaou[s], Gerda Lóczi[t], Hildigunnur Svavarsdóttir[u], Federico Semeraro[v], Peter J. Wright[w], Carlo Clarens[x], Ruud Pijls[y], Grzegorz Cebula[z], Vitor Gouveia Correia[aa], Diana Cimpoesu[ab], Violetta Raffay[ac], Stefan Trenkler[ad], Andrej Markota[ae], Anneli Strömsöe[af], Roman Burkart[ag], Gavin D. Perkins[ah], Leo L. Bossaert[ai], on behalf of EuReCa ONE Collaborators[1]

[a] University Hospital Schleswig-Holstein, Dep. Anaesthesiology and Intensive Care Medicine, Kiel, Germany
[b] University Hospital Schleswig-Holstein, Institute for Emergency Medicine, Kiel, Germany
[c] University Witten/Herdecke, Cologne, Germany
[d] Academic Medical Center, Amsterdam, The Netherlands
[e] National University of Ireland Galway, Ireland
[f] University Hospital of Cologne, Germany
[g] University of Borås, Sahlgrenska University Hospital, Sweden
[h] Norwegian National Advisory Unit on Prehospital Emergency Medicine (NAKOS), Oslo, Norway
[i] Empresa Pública de Emergencias Sanitarias, Almería, Spain
[j] University Hospital Schleswig-Holstein, Dep. Anaesthesiology and Intensive Care Medicine, Campus Lübeck, Germany
[k] University Hospital Innsbruck, Austria
[l] Centre Hospitalier Universitaire Saint-Pierre, Université Libre de Bruxelles, Belgium
[m] Medical Faculty Osijek, Josip Juraj Strossmayer University, Osijek, Croatia
[n] Nicosia General Hospital, Cyprus
[o] Emergency Medical Service of the Central Bohemian Region, Kladno, and J.E. Purkinje University, Masaryk Hospital Usti nad Labem, Czech Republic
[p] Emergency Medical Services Copenhagen, University of Copenhagen, Denmark
[q] Emergency Medical Services, Department of Emergency Medicine, University of Helsinki and Helsinki University Hospital, Helsinki, Finland
[r] University of Lille, France
[s] Konstantopouleio General Hospital, Athens, Greece
[t] Health Care Centers of Csongrad County Hódmezővásárhely - Makó, Hungary
[u] Akureyri Hospital/University of Akureyri, Iceland
[v] Ospedale Maggiore "Carlo Alberto Pizzardi" AUSL Bologna, Italy
[w] Health Service Executive Ballyshannon, Ireland
[x] Luxembourg Resuscitation Council, Luxembourg
[y] Maastricht University, The Netherlands
[z] Jagiellonian University, Kraków, Poland
[aa] Serviço de Emergência Médica Regional - SEMER/EMIR, Portugal
[ab] University of Medicine and Pharmacy Gr.T. Popa and University County Hospital Sf. Spiridon, Iaşi, Romania
[ac] Municipal Institute for Emergency Medicine Novi Sad, Serbia
[ad] P.J.Safarik University, Kosice, Slovakia
[ae] University Medical Centre Maribor, Maribor, Slovenia
[af] Mälardalens University, Västerås, Sweden
[ag] Fondazione Ticino Cuore, Breganzona, Switzerland
[ah] University of Warwick and Heart of England NHS Foundation Trust, Coventry, United Kingdom
[ai] University of Antwerp, Department of Medicine and Health Sciences, Antwerp, Belgium

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* Corresponding author at: University Hospital Schleswig-Holstein, Institute for Emergency Medicine, Germany.
E-mail address: jan-thorsten.graesner@uksh.de (J.-T. Gräsner).

[1] Names listed at the end of the manuscript.

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ABSTRACT

Introduction: The aim of the EuReCa ONE study was to determine the incidence, process, and outcome for out of hospital cardiac arrest (OHCA) throughout Europe.
Methods: This was an international, prospective, multi-centre one-month study. Patients who suffered an OHCA during October 2014 who were attended and/or treated by an Emergency Medical Service (EMS) were eligible for inclusion in the study. Data were extracted from national, regional or local registries.
Results: Data on 10,682 confirmed OHCAs from 248 regions in 27 countries, covering an estimated population of 174 million. In 7146 (66%) cases, CPR was started by a bystander or by the EMS. The incidence of CPR attempts ranged from 19.0 to 104.0 per 100,000 population per year. 1735 had ROSC on arrival at hospital (25.2%), Overall, 662/6414 (10.3%) in all cases with CPR attempted survived for at least 30 days or to hospital discharge.
Conclusion: The results of EuReCa ONE highlight that OHCA is still a major public health problem accounting for a substantial number of deaths in Europe.

EuReCa ONE very clearly demonstrates marked differences in the processes for data collection and reported outcomes following OHCA all over Europe. Using these data and analyses, different countries, regions, systems, and concepts can benchmark themselves and may learn from each other to further improve survival following one of our major health care events.

Introduction

Out-of-hospital cardiac arrest (OHCA) is a major health problem in Europe and in the United States. The numbers of patients who have OHCA annually in these two parts of the world have traditionally been reported to be 275,000 and 420,000 respectively.[1,2] This corresponds with an incidence rate of approximately 38.0–55.0 all-rhythm OHCAs per 100,000 person-years with resuscitation attempted by Emergency Medical Services (EMS).

The best way to describe the epidemiology of a disease is to create a registry to which the disease is reported. With regard to OHCA, such registries can involve an EMS service, a region, or a whole country. A registry can describe changes over time in incidence, survival, and various modes of treatment. An important modifiable factor to measure in OHCA is bystander cardiopulmonary resuscitation (CPR) which reflects the community involvement in treatment of this emergency condition. In terms of OHCA, a number of registries have been built up outside Europe. Of particular note are the Cardiac Arrest Registry to Enhance Survival (CARES), the Resuscitation Outcomes Consortium Epistry (ROC) in North America, the All-Japan Utstein Registry, and the Pan-Asian Resuscitation Outcomes Registry (PAROS).[3–6]

During the last decades a number of registries for OHCA have been implemented in Europe.[7–17] These registries cover varied parts of the participating countries. The greater part of Europe however is not included in a registry with the aim of continuous reporting of OHCA. A registry covering larger areas of Europe should create the opportunity to build an overall picture of the epidemiology of OHCA in these areas.

The lack of a pan-European registry means there is still a gap in actual knowledge regarding the current incidence of OHCA and furthermore, the survival after OHCA. The aim of this project of the European Registry of Cardiac Arrest (EuReCa ONE) was to determine the incidence, process, and outcome for OHCA in a large number of countries in Europe. Major outcomes that were addressed in this prospective analysis were return of spontaneous circulation (ROSC), admission to hospital, and/or 30-day survival.

Methods

EuReCa ONE was an international, prospective, multi-centre one-month study, designed as initial first step to establish a European Registry of Cardiac Arrest (EuReCa).[18] Patients who had an OHCA during October 2014 which occurred in any participating region and who were attended and/or treated by an Emergency Medical Service (EMS) were eligible for inclusion in the study. Patients were eligible for inclusion regardless of performance or non-performance of a resuscitation attempt, arrest aetiology, initial arrest rhythm, age, or gender. The study dataset was developed by the Steering Committee (SC) in accordance with Utstein definitions.[19] A revised Utstein dataset was introduced close to the time of study inception, which included a new category of aetiology i.e. 'medical'. As well as 'presumed cardiac', the 'medical' category includes all other medical causes in which there is no obvious cause of cardiac arrest.[14] In order to facilitate data collection from existing systems, data on aetiology was collected for both the 'presumed cardiac' and 'medical' categories. The EuReCa ONE study is registered with ClinicalTrials.gov (T02236819). The study protocol has been published previously and describes all questions to be addressed in the EuReCa ONE Study (see Supplement S1).[20]

Countries were recruited to participate in EuReCa ONE through an open invitation meeting during the European Resuscitation Council (ERC) Congress in 2013. The recruitment process resulted in 27 countries committing to participate in EuReCa ONE.

Each participating country was requested to identify one National Coordinator (NC). All NCs signed a Memorandum of Understanding agreeing that they were responsible for obtaining ethical approval/waiver for participation in EuReCa ONE, coordinating national data collection, assuring data quality, and for submitting de-identified data for analysis. National Coordinators were supplied with electronic copies of the dataset, coding, and definitions and given a contact for the Study Management Team (SMT) so that any specific queries could be dealt with by the SMT or escalated to the SC as required. Each SMT member acted as a liaison person for a group of countries and kept in contact with NCs in case of issues arising.

Data were extracted from national, regional or local OHCA registries and databases, or by use of a paper version of the EuReCa ONE datasheet for data collection. Data were obtained from: existing registries with national coverage (five countries); existing registries with partial country coverage (eight countries); registries provided by the local Resuscitation Council (three countries); patient ambulance records (three countries). Eight countries used paper-based data collection and reported cases directly to the NC. Data elements were de-identified and data was transcribed by each NC onto a EuReCa ONE Data Export Template and submitted via password encrypted secure electronic transfer to the specially designed EuReCa website. Prior to transcription, NCs were expected to assure the quality of the data being sent in terms of comprehensiveness and adherence to data definitions and coding.

After exploratory analysis on submitted data and clarification of outstanding issues in relation to data quality were addressed with NCs, the final data submission was completed in August 2015.

Statistical analysis

Incidence rates for one month were extrapolated to incidence rates per 100,000 population per year. In countries with partial coverage the covered population was calculated by adding regional populations. Descriptive analyses of patient demographics, case characteristics, and treatment and outcome variables were performed for the whole group as well as for each participating country in order to investigate the degree of variability between countries and regions. Survival was derived from status at 30 days, and replaced by hospital discharge status in case of missing 30 days status. Statistical analysis is based on cases where CPR was started by a bystander or by the EMS.

In order to limit statistical uncertainty, for some analyses only countries with ten or more cases were included. For selected categorical variables, e.g. ROSC or survival, 95% confidence intervals (CI 95) were calculated based on the Poisson distribution.

Role of the funding source

The study was funded by the European Resuscitation Council (ERC) and by the individual registries within participating countries. Co-funding was provided by the German Anaesthesiology Association (BDA). The Laerdal Foundation for Acute Medicine co-funded a meeting of the NCs, the SMT, and the SC. The funding organisations had no influence on the data analysis or preparation of the manuscript.

The ERC appointed a SC that was responsible for the study design, conduct, and data analyses. Technical and administrative support was given by the SMT. Members of the SC had full access to the study data and all NCs were responsible for critical revision of the submitted version of the manuscript.

Results

Patient and process characteristics

Data on 10,682 confirmed OHCAs were collected from 248 different regions in 27 countries, covering an estimated population of 174 million (34%) of 514 million people living in these European countries (Table 1). Seven countries provided national data, other countries reported data from selected regions within the country (range 1–51 regions). The population covered varied from 3% to 100% of the total population of the country. Three countries provided only cases when CPR was started. The lowest number of reported patients for one country was four (Cyprus) and the highest number was 1536 (United Kingdom). In 7146 cases, CPR was started by a bystander or by the EMS. We found an OHCA incidence rate of 84.0 per 100,000 population for patients considered for resuscitation by the EMS. The incidence of CPR attempts ranged from 19.0 to 104.0 per 100,000 population per year (Table 1).

The following calculations are based on all cases where CPR was started by EMS or bystander. Mean patient age was 66.5 (SD 18.6) years, and the median age was 70.0 years, (range 0–104) (Table 2). The majority of patients were male (66.3%). The majority of OHCAs (69.4%) occurred in a private residence. In 54.3% of cases the collapse was witnessed by bystanders and in 11.9% by the EMS. In 47.4% of cases CPR was initiated by a bystander. The cause of OHCA was presumed to be medical in 91.4% of cases. This included cases where the presumed cause was reported as unknown or where data was missing (24.0%), as these are also considered medical (including cardiac) following the Utstein recommendations.[19] A traumatic cause was reported in 4.1% of cases (range 0–16.0%). The proportion of telephone assisted CPR was reported from 21 countries. The

Table 1
Summary data for all participating countries.

Code	Country	Total population (in thousands)	Population covered (in thousands)	Percentage covered	Regions	Cases with CA	CA per 100,000 per year	CPR attempted	CPR per 100,000 per year
A	Austria	8474	1538	18%	7	71	55	54	42
B	Belgium	11,200	1530	14%	6	105	[a]	105	82
CRO	Croatia	4285	1893	44%	6	98	62	66	42
CYP	Cyprus	0.800	0.200	25%	1	6	36	4	24
CZ	Czech Rep.	10,520	4359	41%	7	886	244	379	104
DK	Denmark	5614	1726	31%	1	116	81	101	70
SF	Finland	5439	4445	82%	20	467	126	216	58
F	France	66,318	17,166	26%	44	855	60	743	52
D	Germany	80,620	13,416	17%	51	1369	122	738	66
GR	Greece	11,030	6144	56%	7	253	49	165	32
H	Hungary	9909	1288	13%	3	127	118	85	79
ICE	Iceland	0.328	0.328	100%	6	13	58	10	44
IRL	Ireland	4588	4588	100%	1	209	76	155	41
I	Italy	59,830	8015	13%	4	773	116	428	64
LUX	Luxemburg	0.549	0.549	100%	3	46	102	28	62
NL	Netherlands	16,800	4870	29%	3	250	62	190	47
N	Norway	5048	3931	78%	11	188	57	167	51
PL	Poland	38,530	2265	6%	1	275	146	133	70
P	Portugal	10,460	0.262	3%	1	35	160	16	73
RO	Romania	19,960	5344	27%	3	378	85	229	51
SRB	Serbia	7164	3200	45%	7	488	183	159	60
SK	Slovakia	5421	5421	100%	1	670	148	343	76
SLO	Slovenia	2050	0.660	32%	4	38	69	25	45
E	Spain	47,270	47,270	100%	17	1107	28	756	19
S	Sweden	9593	7482	78%	20	301	[a]	301	48
CH	Switzerland	8081	0.346	4%	1	22	76	14	48
UK	United Kingdom	64,597	26,346	41%	12	1536	[a]	1536	70
	Total	514,478	174,582	34%	248	10,682	–	7146	–

[a] B, S, UK: only cases with cardiopulmonary resuscitation (CPR) attempted.

Table 2
Selected summary findings from all countries. Results are presented as overall mean value or percentage of all cases, and median with range of the individual country values. Calculations are based on all cases where CPR was started by EMS or bystander.

	No. of countries	No. of cases	Overall average	Median of country values	Range of country values
Cases with CPR attempted	27	7146	264.7	159	4–1536
Mean age (years)	27	6826	66.5	66.0	58.4–75.6
Male gender (%)	27	7004	66.3	65.7	50.0–90.0
Medical/cardiac cause[a] (%)	27	7146[a]	91.4	90.1	78.1–100
Traumatic cause (%)	27	7146[a]	4.1	3.7	0–16.5
Location: residence (%)	27	7052	69.4	67.1	46.4–79.9
Telephone CPR (%)	21	3439	29.9	30.4	0–100
Collapse witnessed (%)	27	6815	66.1	67.5	37.4–93.5
Bystander CPR (%)	27	6619	47.4	50.0	6.3–78.0
Shockable rhythm (%)	26	6533	22.2	23.6	4.4–50.0
ROSC (%)	27	6963	28.6	30.6	9.1–50.0

[a] Missing or unknown values were considered as medical/cardiac.

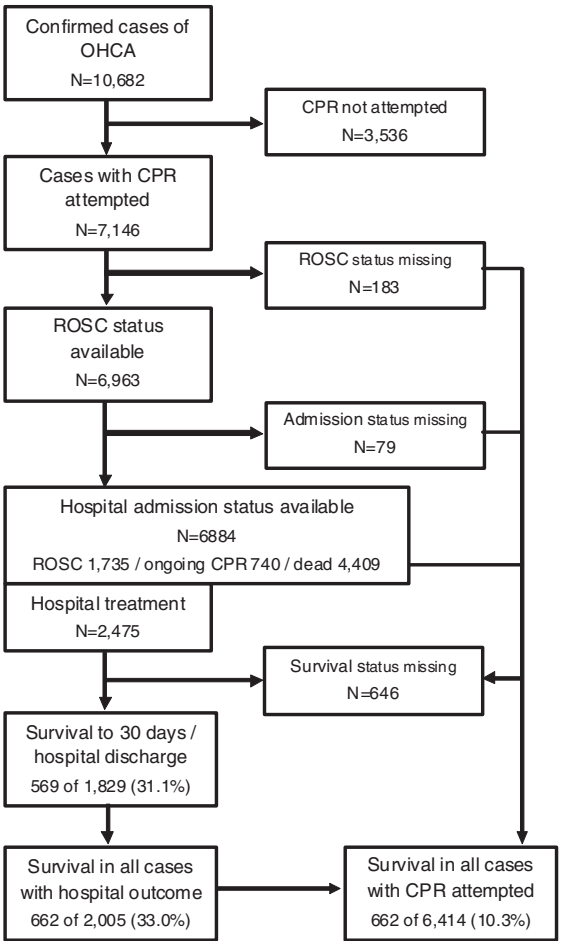
average percentage was 30.0%. A shockable initial rhythm was reported in 22.2% of patients, ranging between 4.4% and 50.0%.

Outcomes

Data on return of spontaneous circulation at any stage (ROSC) was available for 6963 of 7146 patients (97.4%) (Fig. 1). Percentage ROSC for all countries was 28.6% (n = 1994) (Fig. 2). There was a wide range of percentage ROSC reported (9.0–50.0%). Some countries with a small number of cases reported high proportions of ROSC with wide confidence intervals, but the range of reported ROSC from countries with larger numbers of cases and narrow confidence intervals also varied from less than 10.0% to more than 40.0%. The incidence rate of ROSC ranged between 6.0 and 32.0 per 100,000 population per year.

The status on arrival at hospital was known for 6884 of the 7146 patients (96.3%) for whom a resuscitation attempt was started (Fig. 3). Of these patients, 4409 died on scene or en route to the hospital (64.0%). One fourth of patients (n = 1735) had sustained ROSC on arrival at ED (ROSC at hospital) (25.2%), and 740 patients (10.7%) arrived with ongoing CPR. Of the patients with ROSC at hospital for whom survival data was available, 543/1291 (42.0%) survived for 30 days or to hospital discharge. Of the patients with ongoing CPR for whom data was available, 26/538 (4.8%) survived for at least 30 days or to hospital discharge (Fig. 4).

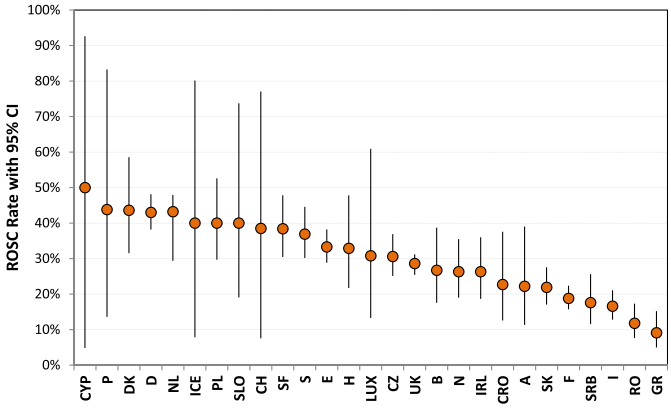
Data on survival to 30 days or to hospital discharge was available for 2005 of patients admitted to hospital, including those with ongoing CPR and missing ROSC at hospital data. Of these patients, 662 (33.0%,) survived. The values of the participating countries ranged from 6.4% to 66.7%. In all patients where CPR was started, and hospital outcome was available (n = 6414), 10.3% survived for at least 30 days after OHCA or to hospital discharge (Fig. 5). This percentage ranged from 1.1% and 30.8% among the participating countries. The extrapolated incidence rate of survival for admitted patients ranged between 0.2 and 17.3 per 100,000 population per year (Supplementary Table S3).



OHCA= out of hospital cardiac arrest,

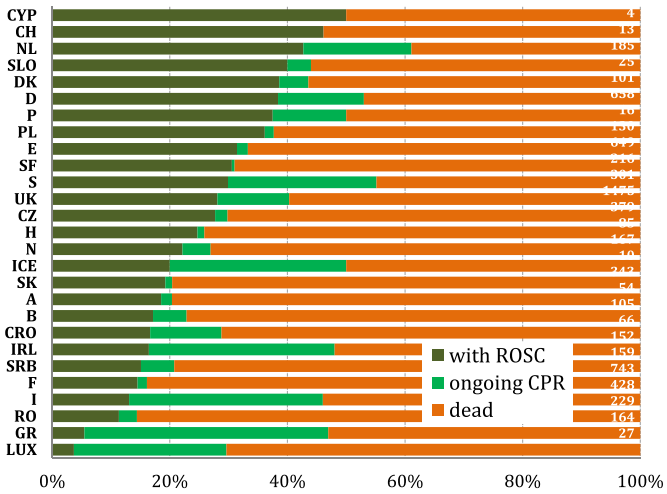
ROSC= Return of spontaneous circulation, CPR= cardiopulmonary resuscitation

Fig. 1. Flow chart with number of cases. OHCA = out of hospital cardiac arrest, ROSC = return of spontaneous circulation, CPR = cardiopulmonary resuscitation.



Abbreviations: ROSC= Return of spontaneous circulation. Abbreviations for Countries names are explained in Table 1.

Fig. 2. ROSC rate in patients with CPR attempted. The vertical lines represent the 95% confidence intervals (CI). The graph includes 6963 patients from 27 countries (range per country 4 – 1475). The overall result is 28.6%. *Abbreviations*: ROSC = return of spontaneous circulation. Abbreviations for Countries names are explained in Table 1.



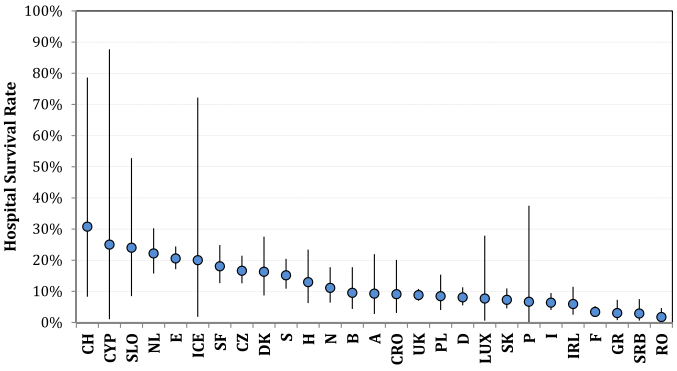
Abbreviations: ROSC= Return of spontaneous circulation, CPR= cardiopulmonary resuscitation, Abbreviations for Countries names are explained in Table 1.

*Patients included in the 'Dead' category either died at scene or were pronounced dead on arrival at hospital. Numbers to the right of each bar represent the total number of cases per country.

Fig. 3. Status on hospital admission (n = 6884)*. *Abbreviations*: ROSC = Return of spontaneous circulation; CPR = cardiopulmonary resuscitation; Abbreviations for countries names are explained in Table 1. *Patients included in the 'Dead' category either died at scene or were pronounced dead on arrival at hospital. Numbers to the right of each bar represent the total number of cases per country.

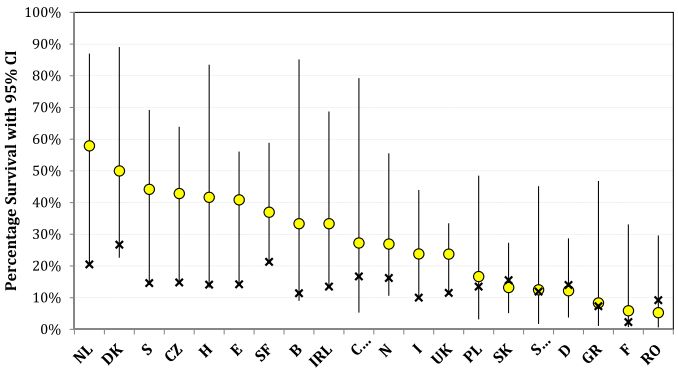
Outcomes for the Utstein comparator group

The Utstein comparator group included patients with a bystander witnessed arrest of suspected cardiac cause and an initial recorded shockable rhythm. In 12.5% of patients (890/7146), all criteria for the Utstein comparator were available (Supplement S2). Seven countries with less than ten patients in the Utstein comparator group were excluded (25 cases). Information on ROSC was available for 845 (98%) of these cases. The overall proportion of ROSC was 56.8%, ranging from 25.0% to 84.6% between countries. Data on survival was available for 733 patients (85%) (Fig. 5). Of these patients, 218 (29.7%) survived for at least 30 days or to hospital discharge. Survival ranged between 5.3% and 57.9%. The incidence rate of survival ranged from 0.1 survivors to 6.3 survivors per 100,000 population (Supplement S3).



Abbreviations for countries names are explained in Table 1.

Fig. 4. Percentage survival in cases with CPR attempted (discharged from hospital alive or alive at least 30 days after event). The vertical lines represent the 95% confidence intervals. The graph includes 6414 patients from 27 countries (range 4 – 1218). The overall rate is 10.3%. Abbreviations for countries names are explained in Table 1.



Abbreviations for Countries names are explained in Table 1.

Fig. 5. Hospital survival rate in the Utstein Comparator Group (cardiac cause, shockable rhythm, and collapse bystander witnessed). Hospital survival data was available for 733 patients (seven countries with less than 10 cases were excluded: Austria, Cyprus, Iceland, Luxembourg, Portugal, Slovenia, Switzerland; n = 25). The vertical lines represent the 95% confidence intervals. The percentage of patients per country who belong to the Utstein Comparator Group is marked with 'x'.
Abbreviations for Countries names are explained in Table 1.

Discussion

This is the first study reporting incidence, community involvement (as bystander CPR), and outcomes following OHCA in 27 European countries. Assuming that the rate of OHCA was similar during the remaining eleven months of the year, we found an incidence rate of 84 per 100,000 population. A previous study reported 87.4 OHCAs per 100,000 person-years for Europe.[21] Thus, our results suggest that the incidence of OHCA in Europe is in the range of what has previously been reported.

We found the overall incidence of OHCA where CPR was started to be 49 patients per 100,000 population. This Fig. includes EMS and bystander treated cardiac arrests. It is clearly higher than previously reported from Europe ten years ago (38.0 per 100,000).[1] On the other hand, our findings are in good agreement with more recent data from national surveys in Denmark and Sweden.[9,10] In our study, for both these estimates, there was substantial variability between countries which may reflect a variation in disease, reporting bias or a natural variability which will be commented upon in the Limitations Section.

The proportion of patients with CPR attempted who were found in ventricular fibrillation was 22.2%. This is a relatively low figure as compared with the reported incidence 10 years ago in Europe (42.9%).[1] However, these findings are in good agreement with a reported decline in the incidence of VF both from Europe and from USA.[22] Our findings also concur with more recent studies of the incidence of VF among patients with OHCA where CPR was attempted.[9] However, there are countries in Europe where a higher incidence of VF has recently been reported.[23]

Three previous studies have reported on the incidence and survival of OHCA from a European perspective. The first survey was published in 1999 and reported that many EMS systems in Europe showed good results in terms of survival after OHCA.[24] The second survey was published in 2005 and reported an overall incidence of 38 EMS-treated OHCA per 100,000 person years in Europe.[1] The corresponding Fig. for ventricular fibrillation (VF) was 17. The overall percentage survival to hospital discharge was 10.7% for all rhythms and 21.2% for VF. It was extrapolated that 29,000 persons were successfully resuscitated each year after OHCA in Europe. The third survey was published in 2011 and included five regional/national registries.[25] The incidence of attempted resuscitations after OHCA was reported to vary between 17.0 and 53.0

per 100,000 person-years. There was a wide variability in terms of bystander CPR and early survival.

Our study reports variability of ROSC from less than 10.0% up to 50.0%, and hospital survival ranging from less than 5.0% to 30.0%. Differences in EMS structures and CPR practices may be a reason for this and it should be remembered that reported data are average values from every country. Nevertheless, we found a similar difference within the systems and variability in the outcome parameters.[26]

The "Utstein comparator group" is one way of defining a uniform population of victims of OHCA with the best chance of survival. Within this group we also found a wide variability of incidence, ROSC, admission to hospital, discharge and/or 30-day survival. It may seem reasonable to assume that there should be similar numbers of survivors in this group. However we found hospital survival rates ranging from less than 6.0% up to 55.0%. Recent publications describe a 30-day survival ranging from 20 to 31% in victims with witnessed cardiac arrest and VF.[11,27] In a longitudinal study from North America, an increasing number of survivors were found but also with variability within the participating systems.[28] In relation to these outcome differences, we might assume differences in bystander-CPR, quality of CPR and post-ROSC treatment in our study group within the different countries and systems. Recommendations for unique CPR metrics have been published and should be used for describing quality.[29] Also, a risk adjustment with more details about the victims and the setting might be helpful to understand the variability in outcome.[30]

Europe is a continent with different nations, cultures, medical treatment standards and OHCA outcomes. Differences in EMS systems and community factors including bystander CPR may also influence the outcome after cardiac arrest.

Limitations

First, the methods of data collection were not standardised between contributing countries and regions and quality control was limited to queries to the NCs. This may explain some of the variation of incidence rates of initiated resuscitation between countries with ranges between 24 and 104 per 100,000 patients per year. Considering that some variables had missing data, it is possible that data were difficult to obtain in certain subgroups, such as patients attended by the EMS for whom resuscitation was considered futile.

Second, the results of our study show large differences in the processes for data collection and outcomes between countries. Percentage ROSC following a resuscitation attempt varied between 9.0% and 50.0%, survival to discharge varied between 6.4% and 66.7%. This wide variation may be due to genuine differences between countries, similar to the large variation in outcome as reported for the Resuscitation Outcome Consortium centres.[4] That study employed rigid and standardised methods of data collection within one nation, to ensure data completeness and data quality. They reported a five-fold range, much less than the 20-fold range in survival rate that is reported in our study. Several explanations therefore may play a role in the wide variability in outcomes in our study. First, our study is a snapshot of OHCA in one month. Given the inherent variability of outcomes of cardiac arrest, especially in small samples in part of the contributing countries, the comparison between countries over such a short time period has limitations. However, the combined data of all countries may add to the robustness of the overall outcome as reported.

Third, variation in incidence rate may be due to seasonal variations or indicate, legal, cultural, and religious differences in the willingness to activate EMS and to initiate resuscitation when a low probability of success is expected, or to terminate efforts in the field, which may affect admission rates. Three countries only reported cases where resuscitation was started or continued by EMS staff. Another issue that can influence outcome is the actual availability of EMS resources to the population served. Higher availability may promote the decision to start resuscitation, especially countries where bystander CPR is lower. These factors are not recorded and it is not known how they may have affected individual cases. This limits our interpretation of the data and attribution of these differences to biological patient factors or to system paramaters of health care for OHCA.

Conclusions

The results of EuReCa ONE highlight that OHCA is still a major public health problem accounting for a substantial number of deaths in Europe.

EuReCa ONE very clearly demonstrates marked differences in the processes for data collection and reported outcomes following OHCA all over Europe. Using these data and analyses, different countries, regions, systems, and concepts can benchmark themselves and may learn from each other to further improve survival following one of our major health care events.

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EuReCa ONE-Local Contributor Group:

Austria: Marc Kaufmann, Markus Thaler, Martin Maier, Gerhard Prause, Helmut Trimmel, Belgium: Diane de Longueville, Thierry Preseau, Dominique Biarent, Christian Melot, Nicolas Mpotos, Koen Monsieurs, Patrick Van de Voorde, Marie Vanhove, Pascale Lievens, Mathias Faniel, Croatia: Slobodanka Keleuva, Milan Lazarevic, Radmila Majhen Ujevic, Mato Devcic, Branka Bardak, Fabijan Barisic, Silvija Hunyadi Anticevic, Cyprus: Marios Georgiou, Czech Republic: Anatolij Truhlář, Jiří Knor, Eva Smržová, Roman Sviták, Robin Šín, Petr Mokrejš, Ondrej Franek, Denmark: Freddy K. Lippert, Finland: Juhana Hallikainen, Marko Hoikka, Timo Iirola, Timo Jama, Helena Jäntti, Raimo Jokisalo, Milla Jousi, Hetti Kirves, Markku Kuisma, Jukka Laine, Sami Länkimäki, Petri Loikas, Vesa Lund, Teuvo Määttä, Heini Nal, Heimo Niemelä, Petra Portaankorva, Marko Pylkkänen, Marko Sainio, Piritta Setälä, Jerry Tervo, Taneli Väyrynen, Timo Jama, France: Davy Murgue, Anne Champenois, Marc Fournier, Daniel Meyran, Romain Tabary, Aurélie Avondo, Gelin Gelin, Bruno Simonnet, Marc Joly, Isabelle Megy-Michoux, Xavier Paringaux, Yves Duffait, Michael Vial, Julien Segard, Sophie Narcisse, David Hamban, Jonathan Hennache, Sylvain Thiriez, Mathieu Doukhan, Carine Vanderstraeten, Jean-Charles Morel, Gilles Majour, Corinne Michenet, Laurent Tritsch, Marc Dubesset, Olivier Peguet, David Pinero, Fréderic Guillaumee, Patrick Fuster, Jean-François Ciacala, Benoît Jardel, Jean-Yves Letarnec, Frank Goes, Pierre Gosset, Muriel Vergne, Christian Bar, Fabienne Branche, Stevens Prineau, Steven Lagadec, Carole Cornaglia, Cécile Ursat, Philippe Bertrand, Jean-Marc Agostinucci, Pierre Nadiras, Géraldine Gonzales de Linares, Line Jacob, François Revaux, Thomas Pernot, Nathalie Roudiak, Agnès Ricard-Hibon, Laurent Villain-Coquet,

Germany: Stefan Beckers, Thomas Hanff, Bernd Strickmann, Nicolai Wiegand, Petra Wilke, Harald Sues, Stefan Bogatzki, Wolfgang Baumeier, Kai Pohl, Bert Werner, Hans Fischer, Torsten Zeng, Erik Popp, Andreas Günther, Andreas Hochberg, Alex Lechleuthner, Jens-Christian Schewe, Hans Lemke, Erich Wranze-Bielefeld, Andreas Bohn, Markus Roessler, Frank Naujoks, Frank Sensen, Torben Esser, Matthias Fischer, Martin Messelken, Christopher Rose, Gabriele Schlüter, Wolfgang Lotz, Michael Corzilius, Claus-Martin Muth, Christian Diepenseifen, Björn Tauchmann, Torsten Birkholz, Andreas Flemming, Stefanie Herrmann, Uwe Kreimeier, Clemens Kill, Frank Marx, Ralph Schröder, Wolfgang Lenz, Greece: Glykeria Botini, Barakos Grigorios, Nikolaos Giannakoudakis, Michail Zervopoulos, Dimitrios Papangelis, Sofia Petropoulou-Papanastasiou, Themistoklis Liaskos, Spyridon Papanikolaou, Andreas Karabinis, Hungary: Attila Zentay, Iceland: Hólmgeir Þorsteinsson, Anna Gilsdóttir, Svavar A. Birgisson, Fjölnir Freyr Guðmundsson, Hallgrímur Hreiðarsson, Björgvin Árnason, Hermann Hermannsson, Gísli Björnsson, Brynjar Þór Friðriksson, Gunnar Baldursson, Ármann Höskuldsson, Jórunn Valgarðsdottir, Matthildur Ásmundardóttir, Guðmundur Guðmundsson, Hjörtur Kristjánsson, Eyþór Rúnar Þórarinsson, Jón Guðlaugsson, Sigurður Skarphéðinsson, Ireland: National Ambulance Service of the Health Service Executive Dublin Fire Brigade, Dublin, Italy: Alberto Peratoner, Andrea Santarelli, Cesare Sabetta, Giovanni Gordini, Giovanni Sesana, Riccardo Giudici, Simone Savastano, Tommaso Pellis, Luxembourg: Jean Beissel, Jean Uhrig, Tom Manderscheid, Marco Klop, Pascal Stammet, Marc Koch, Philippe Welter, Robert Schuman, The Netherlands: Wendy Bruins, Hesam Amin, Norway: Nina Braa, Staale Bratland, Eirik Alnes Buanes, Tomas Draegni, Knut Roar Johnsen, Wenche Torunn Mathisen, Terje Oedegaarden, Marie Oppedal, Alf Stolt-Nielsen Reksten, Mats Eirik Roedsand, Jon Erik Steen-Hansen, Poland: Marta Dyrda, Anna Frejlich, Sławomir Maciąg, Sonia Osadnik, Ireneusz Weryk, Portugal: Eugénio Mendonça, Carlos Freitas, Pinto Cruz, Carmo Caldeira, José Barros, Luis Vale, António Brazão, Nuno Jardim, Fernanda Rocha, Ricardo Duarte, Nicodemos Fernandes, Pedro Ramos, Margarida Jardim, Miguel Reis, Romulo Ribeiro, Sérgio Zenha, Jorge Fernandes, Juan Francisco, David Assis, Fernanda Abreu, Dinarte Freitas, Leonardo Ribeiro, Paulo Azevedo, Débora Calafatinho, Rui Jardim, Aleixo Pestana, Rui Faria, Romania: Bogdan Oprita, Alis Grasu, Paul Nedelea, Sorina Sovar, Florin Agapi, Serbia: Aleksandar Kličković, Aleksandra Lazić, Bogdan Nikolić, Bogdan Zivanovic, Branislav Martinović, Dušan Milenković, Huseinović Damir, Jovanka Koprivica, Kornelija Horvat Jakšić, Margit Pajor, Saša Milić, Mirko Vidović, Radojka Petrovic Glamoclija, Sladjana Andjelic, Vlajovic Sladjana, Zlatko Babić, Zlatko Fišer, Slovakia: Peter Androvic, Lubica Bajerovska, Miroslav Chabron, Viliam Dobias, Eva Havlikova, Bozena Horanova, Renata Kratochvilova, Dana Kubova, Jan Murgas, Juraj Patras, Ladislav Simak, Vladimir Snarskij, Zuzana Zaviaticova, Marcela Zuffova, Spain: Francesc Escalada Roig, Luis Sánchez Santos, Alfredo Echarri Sucunza, Juan A. Cordero Torres, Guadalupe Inza Muñoz, Marta Martínez del Valle, Isabel Ceniceros Rozalen, Enrique Martín Sánchez, María Victoria Raúl Canabal Berlanga, Karlos Ibarguren Olalde, José I. Ruiz Azpiazu, María José García-Ochoa, Rafael Zoyo López-Navarro, José M. Adsuar Quesada, José A. Cortés Ramas, Francisco J. Mellado Vergel, Juan B. López Messa, Patricia Fernández del Valle, Nuria López Cabeza, José M. Navalpotro Pascual, Sweden: The Swedish Association of Local Authorities and Regions, Switzerland: Luciano Anselmi, Federazione Cantonale Ticinese Servizi Ambulanze, Breganzona Claudio Benvenuti, United Kingdom: Nigel Batey, Yorkshire Ambulance, Scott Booth, Patricia Bucher, Charles D. Deakin, Jay Duckett, Chen Ji, Nancy Loughlin, Jenny Lumley-Holmes, Jessica Lynde, Frank Mersom, Carly Ramsey, Clare Robinson, Robert Spaight, Sukhdeep Dosanjh, Gurkamal Virdi, Andrew Whittington.

Conflict of interest statement

There are no financial and personal relationships with other people or organisations that could influence this paper. COI statements are available for all authors.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.resuscitation.2016.06.004.

References

1. Atwood C, Eisenberg MS, Herlitz J, Rea TD. Incidence of EMS-treated out-of-hospital cardiac arrest in Europe. Resuscitation 2005;67:75–80.
2. Rea TD, Eisenberg MS, Sinibaldi G, White RD. Incidence of EMS-treated out-of-hospital cardiac arrest in the United States. Resuscitation 2004;63:17–24.
3. Chan PS, McNally B, Tang F, Kellermann A. Recent trends in survival from out-of-hospital cardiac arrest in the United States. Circulation 2014;130:1876–82.
4. Nichol G, Thomas E, Callaway CW, et al. Regional variation in out-of-hospital cardiac arrest incidence and outcome. JAMA - Journal of the American Medical Association 2008;300:1423–31.
5. Ong ME, Shin SD, De Souza NN, et al. Outcomes for out-of-hospital cardiac arrests across 7 countries in Asia: The Pan Asian Resuscitation Outcomes Study (PAROS). Resuscitation 2015;96:100–8.
6. Hasegawa K, Tsugawa Y, Camargo Jr CA, Hiraide A, Brown DF. Regional variability in survival outcomes of out-of-hospital cardiac arrest: the All-Japan Utstein Registry. Resuscitation 2013;84:1099–107.
7. Gräsner JT, Meybohm P, Fischer M, et al. A national resuscitation registry of out-of-hospital cardiac arrest in Germany-a pilot study. Resuscitation 2009;80:199–203.
8. Sedgwick ML, Dalziel K, Watson J, Carrington DJ, Cobbe SM. Performance of an established system of first responder out-of-hospital defibrillation. The results of the second year of the Heartstart Scotland Project in the 'Utstein Style'. Resuscitation 1993;26:75–88.
9. Stromsoe A, Svensson L, Axelsson AB, et al. Improved outcome in Sweden after out-of-hospital cardiac arrest and possible association with improvements in every link in the chain of survival. European heart journal 2015;36:863–71.
10. Wissenberg M, Lippert FK, Folke F, et al. Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. Jama 2013;310:1377–84.
11. Masterson S, Wright P, O'Donnell C, et al. Urban and rural differences in out-of-hospital cardiac arrest in Ireland. Resuscitation 2015;91:42–7.
12. Blom MT, Beesems SG, Homma PC, et al. Improved survival after out-of-hospital cardiac arrest and use of automated external defibrillators. Circulation 2014;130:1868–75.
13. Cebula GM, Osadnik S, Wysocki M, et al. Comparison of the early effects of out-of-hospital resuscitation in selected urban and rural areas in Poland. A preliminary report from the Polish Cardiac Arrest Registry by the Polish Resuscitation Council. Polish Heart Journal 2016;74:143–8.
14. Van Hoeyweghen RJ, Bossaert LL, Mullie A, et al. Quality and efficiency of bystander CPR. Belgian Cerebral Resuscitation Study Group. Resuscitation 1993;26:47–52.
15. Hubert H, Tazarourte K, Wiel E, et al. Rationale, methodology, implementation, and first results of the French out-of-hospital cardiac arrest registry. Prehospital Emergency Care: Official Journal of the National Association of EMS Physicians and the National Association of State EMS Directors 2014;18:511–9.
16. Ristagno G, Semeraro F, Radeschi G, et al. The "Italian Registry of Cardiac Arrest - RIAC", a National achievement to portrait the Italian reality and to contribute to the wider European vision by "EuReCa". Resuscitation 2014;85:e193–4.
17. Rosell Ortiz F, Mellado Vergel F, Lopez Messa JB, et al. Survival and neurologic outcome after out-of-hospital cardiac arrest. Results of the andalusian out-of-hospital cardiopulmonary arrest registry. In: Revista espanola de cardiologia; 2016 [English ed].
18. Gräsner JT, Bottiger BW, Bossaert L. European Registry of Cardiac Arrest ONESC, EuReCa ONESMT. EuReCa ONE – ONE month – ONE Europe – ONE goal. Resuscitation 2014;85:1307–8.
19. Perkins GD, Jacobs IG, Nadkarni VM, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the utstein resuscitation registry templates for out-of-hospital cardiac arrest: a statement for healthcare professionals from a Task Force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. Resuscitation 2015;96:328–40.
20. Wnent J, Masterson S, Gräsner JT, et al. EuReCa ONE - 27 Nations, ONE Europe, ONE Registry: a prospective observational analysis over one month in

27 resuscitation registries in Europe – the EuReCa ONE study protocol. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine 2015;23:7.
21. Berdowski J, Berg RA, Tijssen JG, Koster RW. Global incidences of out-of-hospital cardiac arrest and survival rates: Systematic review of 67 prospective studies. Resuscitation 2010;81:1479–87.
22. Keller SP, Halperin HR. Cardiac arrest: the changing incidence of ventricular fibrillation. Current Treatment Options in Cardiovascular Medicine 2015;17:392.
23. Hulleman M, Zijlstra JA, Beesems SG, et al. Causes for the declining proportion of ventricular fibrillation in out-of-hospital cardiac arrest. Resuscitation 2015;96:23–9.
24. Herlitz J, Bahr J, Fischer M, Kuisma M, Lexow K, Thorgeirsson G. Resuscitation in Europe: a tale of five European regions. Resuscitation 1999;41:121–31.
25. Gräsner JT, Herlitz J, Koster RW, Rosell-Ortiz F, Stamatakis L, Bossaert L. Quality management in resuscitation—towards a European cardiac arrest registry (EuReCa). Resuscitation 2011;82:989–94.
26. Neukamm J, Gräsner JT, Schewe JC, et al. The impact of response time reliability on CPR incidence and resuscitation success: a benchmark study from the German Resuscitation Registry. Critical Care 2011;15:R282.
27. Ringh M, Jonsson M, Nordberg P, et al. Survival after public access defibrillation in Stockholm, Sweden—a striking success. Resuscitation 2015;91:1–7.
28. Daya MR, Schmicker RH, Zive DM, et al. Out-of-hospital cardiac arrest survival improving over time: results from the Resuscitation Outcomes Consortium (ROC). Resuscitation 2015;91:108–15.
29. Meaney PA, Bobrow BJ, Mancini ME, et al. Cardiopulmonary resuscitation quality: [corrected] improving cardiac resuscitation outcomes both inside and outside the hospital: a consensus statement from the American Heart Association. Circulation 2013;128:417–35.
30. Gräsner JT, Meybohm P, Lefering R, et al. ROSC after cardiac arrest—the RACA score to predict outcome after out-of-hospital cardiac arrest. European Heart Journal 2011;32:1649–56.