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Clinical paper

Time of out-of-hospital cardiac arrest is not associated with outcome in a metropolitan area: A multicenter cohort study

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Abstract

Aim: Whether time of day influences survival after out-of-hospital cardiac arrest (OHCA) remains controversial. We compared outcomes after OHCA between day and night and explored whether characteristics of pre-hospital advanced life support (ALS)-quality varied by time of day.

Methods: We conducted a prospective cohort study of individuals that suffered a non-traumatic OHCA in the city of Vienna between August 2013 and August 2015 and who received resuscitative efforts by EMS. We compared clinical outcomes between day and night, defined as 7:00 pm–7:00 am based on EMS shift time including rates of sustained return of spontaneous circulation (ROSC), 30-day survival and favourable neurologic outcome (cerebral performance category 1 or 2). ALS quality measures included time to first medical contact, time to first shock, total dose of epinephrine, and multiple ALS performance measures.

Results: We included 1811 patients (37% female) with a mean age of 67 ± 16 years in our analyses. Rates of ROSC and 30-day survival with favourable neurological outcome did not differ between day or night (30% vs 28%, $p = 0.33$; 12% vs. 11%, $p = 0.51$, respectively). These results remained unchanged after multivariate adjustment for ROSC (RR, 1.1; 95% CI, 1.0–1.3, $p = 0.19$) and 30-day survival with favourable neurological outcome (RR, 1.2; 95% CI, 1.0–1.5, $p = 0.10$). The quality of ALS did not differ between day and night.

Conclusions: In contrast to previous studies, there was no significant difference in sustained ROSC rates and 30-day survival with favourable neurological outcome after OHCA between day and night in the city of Vienna. This is likely due to nearly identical high bystander CPR rates and identical ALS performance provided by EMS personnel irrespective of time of the day.

Keywords: Out-of-hospital cardiac arrest, Emergency medical services, Survival, Resuscitation, Critical care outcomes

Introduction

Out of hospital cardiac arrest (OHCA) remains a major public health problem that claims over 770,000 lives in Europe and the US annually.[1,2] Despite ongoing public efforts to increase lay awareness and bystander cardiopulmonary resuscitation (CPR), only 10% of patients admitted after OHCA survive to hospital discharge.[2]

Certain pre-hospital factors such as bystander CPR, high quality CPR and early defibrillation are linked with improved outcomes after

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OHCA.[3–5] Recent studies have reported significantly lower rates of return of spontaneous circulation (ROSC) for OHCA patients at night compared to daytime.[6–10] These studies reported significant differences in study population at day vs. night, especially in elements of the Utstein-style guidelines[11] such as age, location of arrest, witness status, bystander CPR and initial rhythms[6] as well as significant differences in automated external defibrillator (AED) use and response time intervals by time of day.[8]

Most recently, a large OHCA cohort study from France reported significantly worse outcomes at night with lower rates of bystander CPR and AED use.[12] The quality of in-hospital post-arrest care did not differ by time of day, consistent with our own previously published data, whereas we did not see any differences in outcome.[13] A recent Japanese study reported a higher risk of CPR-related chest injuries during night treatment, but no differences in outcome after OHCA.[14] None of these studies analysed whether the quality of advanced life support (ALS) provided by emergency medical services (EMS) varied by daytime and thus may have contributed to these different outcomes. This is important, because the quality of EMS ALS is an additional potentially improvable component of prehospital resuscitation.

Given existing controversy whether time of day affects outcomes after OHCA we conducted a prospective study of non-traumatic OHCA patients to determine potential differences outcomes after OHCA such as ROSC, 30-day survival and 30-day survival with favourable outcome for patients admitted night-time versus daytime, weekend versus weekday and on versus off-hours. We performed exploratory analysis to assess potential differences in prehospital ALS quality during day and night.

Methods

Study design

A detailed description of the study design has already been described elsewhere.[15] In short, the Vienna Cardiac Arrest Registry (VICAR) was used as source database of the present investigation. VICAR is a prospective multi-center registry of all patients who receive resuscitative efforts by the Viennese emergency medical system (EMS) after OHCA in metropolitan Vienna. In our analysis cohort, we included all adults ≥18 years of age who suffered a non-traumatic OHCA between August 2013 and August 2015. This study was approved by the local ethics committee of the Medical University of Vienna (EK No. 1221/2013) with waiver of informed consent due to minimal risk of study participation.

Study setting and local emergency medical system

The city of Vienna extends across an area of ˜415 km^2 and holds 1.89 million inhabitants. The Viennese EMS is a two-tiered system that responds to approximately 1000 OHCA cases annually[15,16] and transports OHCA patients to one of 7 different hospitals based on geographical and logistic reasons. There is a 24/7 network offering an immediate PCI availability for patients with acute ST-elevation myocardial infarction in the region.

Data acquisition and quality of resuscitation measures

Data collection was conducted in accordance with the Utstein style recommendations for cardiac arrest related documentation.[11] Digital protocols of all OHCA cases of the treating emergency physicians and EMS personal were screened. Data (such as first medical contact time, time to first shock, total dose of epinephrine) were obtained by trained chart reviewers and inserted into a predefined electronic record abstraction form.

Data on ALS performance (compression rate/min, hands off episodes >30 s, hands on fraction <75%, ventilation rate/min and the use of airway device) was evaluated by trained personnel and physicians via the screening of transthoracic impedance measurements and vital parameters of recorded defibrillator-tracings using CODE-STAT Reviewer software package (Physio-Control, Redmond, WA, USA) and inserted into a standardized predefined feedback layout. The feedback protocol was recently described elsewhere.[15]

Time definitions

Patients were stratified into groups according to the time the emergency call was received. Daytime was defined as 7:01 am–06:59 pm and night-time was defined as 7:00 pm–7:00 am based on EMS shift times. Weekdays included Monday to Friday and weekends Saturday and Sunday. Off-hours were defined as night-time from Monday to Friday plus the entire weekend.

Endpoint definition

A composite of 30-day survival and favourable cerebral performance category (CPC) was defined as primary endpoint. Sustained ROSC and 30-days survival (irrespective of neurological outcome) were chosen as secondary endpoints.

Favourable neurological outcome was defined as a CPC 1 (good neurologic function) or 2 (moderate disability). Unfavourable neurological outcome was defined as CPC 3–5 (severe disability, vegetative state, or death) or persistent unresponsiveness due to analgosedation during the study period or before death in accordance to the Utstein recommendations.[17]

Sustained ROSC was defined as spontaneous circulation for ≥20 min.

Outcome data was obtained through hospital records and discharge letters as well via contacting the treating physician at the admitting department by trained study fellows.

Statistical analysis

We present categorised data as counts (relative frequency), and continuous data as mean ± standard deviation or median (25–75% interquartile range), as appropriate. The exposure of interest was off-hour. This was defined as (A) night-time (7:00 pm–7:00 am) versus daytime (7:01 am–6:59 pm); as (B) weekend (Saturday or Sunday) versus weekday (Monday to Friday), or (C) as off-hour versus on-hour (a combination of A and B). We tabulated baseline variables according to exposure status. For continuous variables, we used the Mann–Whitney U test, for categorised variables we used a chi-squared test to test the null hypothesis of no difference between exposure groups. We used generalised linear regression models to estimate the effect of weekday on each of the three outcomes (sustained ROSC, 30-day survival, CPC 1 or 2 at day 30) separately. The effect was quantified as risk ratio with a 95% confidence interval using a log-link function. We selected covariables for the multivariable models based on clinical reasoning. These variables included age, sex, initial shockable rhythm as possible confounder candidate variables. We categorised age as quintiles, which we then used for the multivariable models. We tested for linear effects and for first order interactions using the likelihood ratio test. Missing data were assumedly non-informative and infrequent, therefore complete case analyses were performed. For data management and analyses we used MS Excel (Microsoft Corporation® Redmond, USA) and Stata 14 for Mac (Stata Corp, College Station, TX, USA). If not otherwise stated, a two-sided p-value <0.05 was considered statistically significant.

Results

Of all patients enrolled in the VICAR registry (n = 2209), we analysed data from 1811 patients >18 years with non-traumatic OHCA who were resuscitated. Of those patients, 1179 (65%) suffered OHCA between 7 am and 7 pm (day) and 632 (35%) between 7:01 pm and 6:59 am (night) (Fig. 2). On weekdays, 1325 (73%) patients had OHCA whereas 486 (27%) patients had OHCA on weekends. During on-hours 868 (48%) patients suffered an OHCA, whereas 943 (52%) patients had an OHCA during off-hours.

Tables 1–3 show baseline characteristics, including distribution of cardiac arrest related and quality parameters by groups of time of day, weekday and off-hours for the study population as well as outcome parameters.

Baseline characteristics

The mean age of patients was 67 ± 16 years. Patients suffering OHCA at night were younger compared to patients during daytime as well as off-hours compared to on-hours (66 vs. 69 years, $p < 0.01$), while there was no significant difference between weekday and weekend (68 vs. 67 years, $p = 0.39$). The proportion of female patients was slightly higher during daytime (38% vs. 33%, $p = 0.046$).

Prehospitalization arrest characteristics

More than half of OHCA were witnessed, with fewer witnessed arrests during off hours compared to on hours (56% vs. 61%, $p = 0.022$) and, although statistically not significant, fewer witnessed arrests during night-time (60% vs. 55%, $p = 0.065$).

Bystander CPR was performed in more than half of all cases, with similar proportions of bystander CPR for groups A and B (58% day vs. 55% night, $p = 0.196$; 55% weekend vs. 57% weekday, $p = 0.285$). In contrast, more patients received bystander CPR on-hours compared to off-hours (60% vs. 54%, $p = 0.023$).

Cardiac arrests at night-time (83% vs. 61%, $p < 0.001$) and off-hours (77% vs. 60%, $p < 0.001$) were more likely to occur at home. Although the majority of arrests also happened at home during daytime and on-hours, the proportion of cardiac arrests that occurred in public places was higher during daytime (27% vs. 12%, $p < 0.01$) and on-hours (28% vs. 16%, $p < 0.01$). Only 2.6% of patients had a cardiac arrest during transport to hospital with no difference between groups.

The majority of patients in our cohort (72%) initially had a non-shockable rhythm (asystole or pulseless electrical activity [PEA]), whereas only 28% had an initially shockable rhythm (ventricular fibrillation or pulseless ventricular tachycardia). There were, although statistically not significant, more shockable initial rhythms in patients with arrest during daytime (29% day vs. 25% night, $p = 0.069$) and on-hours (29% on-hours vs. 26% off-hours, $p = 0.17$).

Table 1 – Baseline characteristics by exposure group.

	All	A		P-value	B		P-value	C		P-value
	n = 1811	Daytime n = 1179	Night-time n = 632		Weekday n = 1325	Weekend n = 486		On-hours n = 868	Off-hours n = 943	
Age, mean (SD)	67 (16)	69 (15)	64 (16)	<0.001	68 (15)	67 (16)	0.39	69 (15)	66 (16)	<0.001
Female, n (%)	661 (37)	450 (38)	211 (33)	0.05	478 (36)	183 (38)	0.54	331 (38)	330 (35)	0.17
Witnessed, n (%)	1051 (58)	703 (60)	348 (55)	0.07	772 (58)	279 (57)	0.75	528 (61)	523 (56)	0.02
Bystander, n (%)	1026 (57)	681 (58)	345 (55)	0.20	761 (57)	265 (55)	0.29	516 (60)	510 (54)	0.02
Initial rhythm, n (%)										
VF/VT	504 (28)	345 (29)	159 (25)	0.07	369 (28)	135 (28)	1.00	255 (29)	249 (26)	0.17
PEA	558 (31)	358 (30)	200 (32)	0.60	403 (30)	155 (32)	0.57	265 (31)	293 (31)	0.84
Asystolie	748 (41)	475 (40)	273 (43)	0.25	552 (42)	196 (40)	0.63	347 (40)	401 (43)	0.27
Place, n (%)										
Home	1244 (69)	722 (61)	522 (83)	<0.001	895 (68)	349 (72)	0.09	522 (60)	722 (77)	<0.001
Public	392 (22)	318 (27)	74 (12)	<0.001	301 (23)	91 (19)	0.07	246 (28)	146 (16)	<0.001
En Route	47 (3)	32 (3)	15 (2)	0.76	37 (3)	10 (2)	0.50	24 (3)	23 (2)	0.77
Nursing home	98 (5)	80 (7)	18 (3)	<0.001	69 (5)	29 (6)	0.56	54 (6)	44 (5)	0.15
Doctor's office	24 (1)	23 (2)	1 (0.2)	<0.001	21 (2)	3 (0.6)	0.16	21 (2)	3 (0.3)	<0.001
Unknown	5 (0.3)	4 (0.3)	1 (0.2)	0.66	2 (0.2)	3 (0.6)	0.12	1 (0.1)	4 (0.4)	0.38

Abbreviations: PEA: pulseless electrical activity; SD: standard deviation; VF: ventricular fibrillation; VT: pulseless ventricular tachycardia.
Time definitions: daytime = 7:00 am–07:00 pm; night-time = 7:00 pm–7:00 am; weekday = Monday to Friday; weekend = Saturday & Sunday; off-hours = night-time from Monday to Friday & entire weekend.

Table 2 – ALS quality by exposure group.

	All	A		P-value	B		P-value	C		P-value
		Daytime	Night-time		Weekday	Weekend		On-hours	Off-hours	
	n = 1811	n = 1179	n = 632		n = 1325	n = 486		n = 868	n = 943	
First medical contact (min), mean (SD)	7 (3)	7 (4)	7 (3)	0.91	8 (4)	7 (3)	0.04	8 (4)	8 (3)	0.11
Number of shocks applied, mean (SD)	4 (4)	3 (4)	4 (4)	0.20	4 (4)	4 (4)	0.21	4 (4)	4 (4)	0.82
Time to first shock from emergency call (min), mean (SD)	14 (10)	13 (10)	14 (9)	0.28	13 (9)	15 (10)	0.28	13 (9)	15 (10)	0.04
Total dose of epinephrine in mg, mean (SD)	3 (2)	3 (2)	4 (2)	0.02	4 (2)	3 (2)	0.14	4 (2)	4 (2)	0.27
Compression rate (bpm), mean (SD)[a]	109 (10)	110 (10)	108 (9)	<0.001	109 (10)	109 (10)	0.88	110 (11)	108 (10)	0.002
Hands-off episodes > 30 s, n (%)	599 (33)	393 (33)	206 (33)	0.75	443 (33)	156 (32)	0.59	290 (33)	309 (33)	0.77
Hands on fraction < 75%, n (%)	235 (13)	159 (14)	76 (12)	0.35	182 (14)	53 (11)	0.10	124 (15)	111 (12)	0.10
Airway-Device, n (%)	1348 (74)	883 (75)	465 (74)	0.54	982 (74)	366 (75)	0.61	643 (74)	705 (75)	0.74
Laryngeal tube, n (%)	430 (24)	272 (23)	158 (25)	0.36	328 (25)	102 (21)	0.10	209 (24)	221 (23)	0.75
Endotracheal tube, n (%)	902 (50)	599 (51)	303 (48)	0.25	644 (49)	258 (53)	0.09	426 (49)	476 (51)	0.55
Ventilation rate (/min), mean (SD)	6 (4)	6 (4)	6(4)	0.47	6 (4)	6 (4)	0.32	6 (4)	6 (4)	0.54
etCO2 before ROSC (mmHg), mean (SD)	31 (19)	30 (19)	32 (29)	0.07	31 (19)	31 (19)	0.91	30 (19)	31 (20)	0.28
Time from emergency call to ROSC (min), mean (SD)	30 (17)	29 (17)	32 (16)	0.18	30 (17)	30 (15)	0.84	29 (17)	31 (16)	0.21

Abbreviations: CPR: cardiopulmonary resuscitation; min: minutes; s: seconds; ROSC: return of spontaneous circulation; SD: standard deviation.
Time definitions: daytime = 7:01 am–06:59 pm; night-time = 7:00 pm–7:00 am; weekday = Monday to Friday; weekend = Saturday & Sunday; off-hours = night-time from Monday to Friday & entire weekend.
[a] Data available for n = 1715.

Table 3 – Outcome characteristics by exposure group.

	All	A		P-value	B		P-value	C		P-value
		Daytime	Night-time		Weekday	Weekend		On-hours	Off-hours	
	n = 1811	n = 1179	n = 632		n = 1325	n = 486		n = 868	n = 943	
Any ROSC, n (%)	704 (39)	463 (39)	241 (38)	0.65	504 (38)	200 (41)	0.23	337 (39)	367 (39)	1.00
Sustained ROSC, n (%)	536 (30)	358 (30)	178 (28)	0.33	373 (28)	163 (34)	0.03	253 (29)	283 (30)	0.69
30-day survival, n (%)	292 (16)	188 (16)	104 (17)	0.78	200 (15)	92 (19)	0.05	133 (15)	159 (17)	0.37
30-day survival with CPC 1 or 2, n (%)	213 (12)	143 (12)	70 (11)	0.51	148 (11)	65 (14)	0.18	101 (12)	112 (12)	0.84

Abbreviations: CPC: cerebral performance category; ROSC: return of spontaneous circulation.
Time definitions: daytime = 7:00 am–07:00 pm; night-time = 7:00 pm–7:00; weekday = Monday to Friday; Weekend = Saturday & Sunday; off-hours = night-time from Monday to Friday & entire weekend.

Outcomes

Daytime vs. night-time

In the univariate model, there was no significant difference in ROSC rates (30% and 28%, respectively, RR, 1.1; 95% CI, 0.9–1.3, $p = 0.33$) and 30-day survival (16% and 16%, RR, 1.0; 95% CI, 0.8–1.2 $p = 0.78$) between day- and night-time. After multivariate adjustment for age, sex and initial rhythm at daytime compared with night-time, the probability of ROSC (RR, 1.1; 95% CI, 1.0–1.3, $p = 0.19$) and 30-day survival (RR, 1.1; 95% CI, 0.9–1.3, $p = 0.43$) remained unaltered. There was also no significant difference in the adjusted model for 30-day survival concerning favourable neurological outcome (RR, 1.2; 95% CI, 1.0–1.5, $p = 0.10$) (Fig. 1).

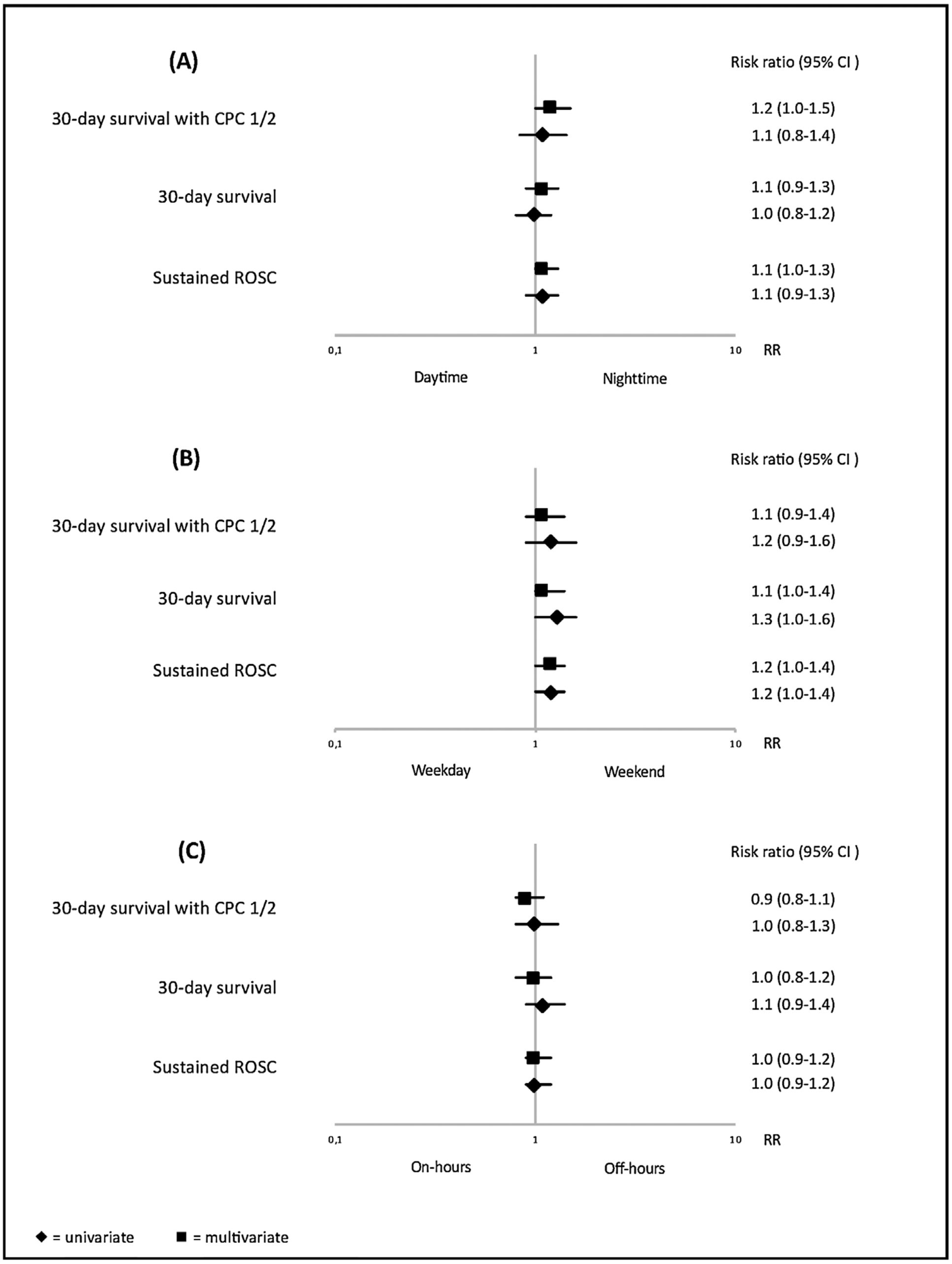

Fig. 1 – Forest plot of comparison (daytime vs. night-time (A)), (weekend vs. weekday (B)), (off-hours vs. on-hours (C)). Abbreviations: CPC: cerebral performance category; ROSC: return of spontaneous circulation; RR: risk ratio.

Weekend vs. weekday

We observed higher ROSC rates on weekends compared to weekdays (34% and 28%, respectively, RR, 1.2; 95% CI, 1.0–1.4, $p = 0.02$ and 30-day survival (19% and 15%, RR, 1.3; 95% CI, 1.0–1.6, $p = 0.05$) but there was no significant difference in 30-day survival with favourable neurological outcome on weekends compared to weekdays (14% and 11%, RR, 1.2; 95% CI, 0.9–1.6, $p = 0.17$).

After multivariate adjustment, higher ROSC rates on weekends remained unvaried (RR, 1.2; 95% CI, 1.0–1.4, $p = 0.01$). There was no significant difference in 30-day survival (RR, 1.1; 95% CI, 1.0–1.4, $p = 0.14$) and 30-day survival with favourable neurological outcome between weekends and weekdays (RR, 1.1; 95% CI, 0.9–1.4, $p = 0.40$) in the adjusted model (Fig. 1).

Off-hour vs. on-hour

In the univariate analyses, we found no difference in ROSC rates in off-hours compared to on-hours (30% and 29%, respectively, RR, 1.0; 95% CI, 0.9–1.2, $p = 0.69$), 30-day survival (17% and 15%, RR, 1.1; 95% CI, 0.9–1.4, $p = 0.37$) and 30-day survival with favourable neurological outcome (12% and 12%, RR, 1.0; 95% CI, 0.8–1.3, $p = 0.84$).

In the multivariate analyses the results remained unvaried. ROSC rates (RR, 1.0; 95% CI, 0.9–1.2, $p = 0.72$), 30-day survival (RR, 1.0; 95% CI, 0.8–1.2, $p = 0.98$) and 30-day survival with favourable neurological outcome (RR, 0.9; 95% CI, 0.8–1.1, $p = 0.49$) showed no significant difference in the adjusted model (Fig. 1).

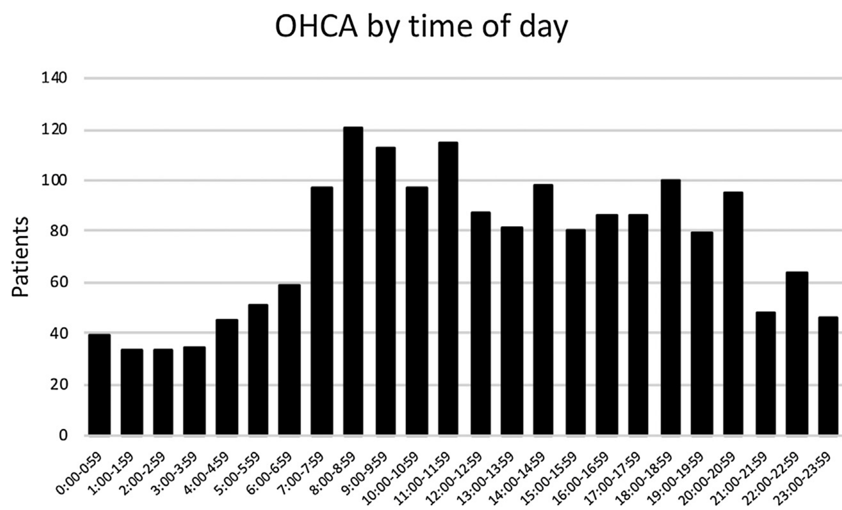

Fig. 2 – Cardiac arrests by hour of day showing a peak starting at daytime and decreasing at night-time. X-axis: hour of day. Y-axis: count of patients. Abbreviations: OHCA: out-of-hospital cardiac arrest.

Quality of advanced life support

Time to first medical contact did not differ between day and night-time (7 min. day vs. 7 min. night, $p = 0.91$) or off vs. on-hours (8 min off-hours vs 8 min on-hours, $p = 0.11$), but the average time-to-first medical contact was shorter on weekends (8 min weekday vs 7 min weekend, $p = 0.04$). Nevertheless, time from emergency call to first shock did not differ between day and night-time (13 min day vs. 14 min night, $p = 0.28$) or weekend vs. weekday (13 min weekday vs 15 min weekend, $p = 0.28$), but was shorter at on-hours (15 min off-hours vs 13 min on-hours, $p = 0.04$). Use of mechanical CPR devices was higher at night-time compared to daytime (45% and 38% respectively, $p = 0.01$) but did not differ between weekend and weekday (41% and 41% respectively, $p = 0.97$) or off- vs. on-hours (43% and 39% respectively, $p = 0.12$). Throughout the observation period mean compression rates per minute showed excellent values as recommended by the current European Resuscitation Council (ERC) guidelines in all groups (110 bpm day vs. 108 bpm night, $p = < 0.001$; 109 bpm weekday vs 109 bpm weekend, $p = 0.88$; 108 bpm off-hours vs 110 bpm on-hours, $p = 0.002$). Furthermore, hands-off episodes >30 s did not vary between the groups (33% day vs. 33% night, $p = 0.75$; 33% weekday vs 32% weekend, $p = 0.59$; 33% off-hours vs 33% on-hours, $p = 0.77$). Regarding the use of airway devices there was no significant difference between groups (75% day vs. 74% night, $p = 0.54$; 74% weekday vs 75% weekend, $p = 0.61$; 75% off-hours vs 74% on-hours, $p = 0.74$). Detailed information regarding quality of advanced life support measures are shown in Table 2.

Discussion

In contrast to other studies,[6–10,12] the rates of ROSC, 30-day survival and favourable neurological outcome was not influenced by the time of day or on- and off-hours in this prospective multi-centre registry study. In addition, our exploratory analysis did not reveal significant differences in the quality of prehospital ALS during OHCA.

Impact of bystander CPR

Compared to previous studies, sustained ROSC rates, 30-day survival or 30-day favourable neurological outcome did not differ by time of day in our study cohort.

Nevertheless, we observed higher ROSC rates on weekends compared to weekdays, although throughout there was no difference in 30-day survival (CPC 3–5) and 30-day survival with favourable neurological outcome (CPC 1–2).

Baseline patient and prehospitalization characteristics were similar between the groups with minor exceptions. For example, patients who experienced an OHCA at night and off-hours were younger compared to patients during daytime; the proportion of females was slightly higher during daytime. We previously reported that the quality of post arrest care and outcomes after OHCA do not differ by time of day at our institution, a specialized cardiac arrest center in Vienna.[14] In contrast, Karam et al. reported poorer neurologic outcomes in survivors of OHCA during off-hours.[12]

The majority of cardiac arrests in our cohort were witnessed irrespective of time of the day and weekday, respectively. Although the majority of OHCA occur at home during daytime, the likelihood of suffering a cardiac arrest in a public place is expectably higher at daytime.

Furthermore, Karam et al. reported major differences in bystanders' response to OHCA according to the time of cardiac arrest, with a lower rate of bystander CPR and AED use during off-hours.[12]

In contrast, we demonstrated overall high bystander CPR rates regardless of time of day. However, similar to other studies, bystander CPR was less frequent and OHCA less often witnessed during off hours. Interestingly, despite this, outcomes were nearly identical. In our study, 'bystander CPR' was defined as basic life support observed by EMS upon arrival. This includes laypersons as well as organised first responder systems, although this definition has to be updated in future studies and is under discussion right now.[18] Dispatchers use integrated maps and encourage bystanders to retrieve available AEDs from nearby public places if feasible.

Moreover, police officers with an automated external defibrillator (AED) are dispatched to the scene as first responders, if the OHCA is already identified by the dispatch center during the initial emergency call and followed by dispatcher-assisted CPR. In addition, the organised first responder system in Vienna is being expanded to include fire fighters with AED being dispatched to an OHCA. These concepts both are not new,[19] Weaver et al. emphasized the importance of widespread AED use by first responder fire fighters as crucial component of OHCA treatment in their 1988 seminal study.[20]

More recently, Hansen et al. showed that bystander CPR and AED use were strongly associated with increased survival.[21] The higher prevalence of initially shockable rhythm and arrests in public areas during daytime justifies ongoing efforts to expand public access defibrillation and periodical awareness campaigns.

In contrast, the high proportion of patients with initially non-shockable rhythm is consistent with the international literature.[22–24] This is a good reminder that bystanders and first responders should perform CPR independently of AED availability.

In contrast to previous studies, we can show oppositional results with nearly identical survival rates regardless of temporal differences including all admitting hospitals in the city of Vienna. Translating this discussed factor to our prehospital setting in our metropolitan area, we can state that the Municipal Ambulance of Vienna serves high quality staff 24 h and 7 days a week, both in terms of quantity and expertise.[16]

Quality of ALS

Several studies have recently reported reduced survival and poorer neurologic outcomes at night vs. day. These studies were limited in that they did not report quality of ALS thus not providing information on the potential cause of this observed difference.[6–10,12] We for the first time are able to demonstrate in exploratory analysis that quality of ALS measures and patient outcome is not affected by time and day of OHCA.

High quality ALS and post-arrest critical care management are crucial determinants of patient outcomes and therefore emphasized as key links in the chain of survival after OHCA by current guidelines.[3] Previous studies investigating the quality of ALS during in-hospital and out-of-hospital resuscitation have reported that low quality CPR is common.[25,26] In contrast, our data show a constant high level of CPR performance during the observation period with regards to chest compression rate, hands-on fraction and ventilation rate. This performance likely reflects a long tradition of excellent cooperation and research collaboration between the Medical University of Vienna and Vienna EMS over the past 15 years. In addition, EMS service in Vienna is homogenous with regards to training and thus may differ from other countries with a more fragmented and privatized EMS system.

Mechanical chest compression is currently controversially discussed in resuscitation science.[27] Current ERC-guidelines do not recommend a general use of these devices, but do recommend them for special circumstances (e.g., during transport).[3] Current evidence suggests that mechanical chest compression devices are not superior to conventional high-quality manual chest compressions in improving survival to hospital discharge with good neurologic function.[27]

In our observation period, we observed a significantly higher use of mechanical devices during night-time without adversely affecting the neurological outcome in our cohort.

Limitations

First and foremost, the major limitation of the present investigation reflects that it was conducted within a single urban area. While we may have offset a potential selection bias by including data from all admitting hospitals in our multi-centre analysis, intrinsic characteristic of the Viennese EMS system and its close collaboration with our institution over many years may explain differences to previous studies and limit the generalizability of our results. Second, we did not perform formal analysis for any centre effects, which may explain differences in unadjusted results for ROSC and 30-day survival between weekends and weekdays. Third, based on available data, hands-off episodes during ALS were defined as > 30 s which differs from the usual metric (>10 s). Moreover, we do not present data related to the quality of in-hospital post arrest care such as target temperature management, percutaneous coronary intervention or extra corporal life support (ECLS) that may affect 30-day survival and neurological outcome. However, we previously demonstrated no difference in the quality of in-hospital post-arrest care by time of day at Vienna General hospital, the largest post-cardiac arrest care center in Vienna.[14]

Conclusions

In the present analysis, we found no significant difference in the quality of advanced life support during OHCA irrespective of day and daytime, with subsequently constant high rates of bystander CPR administered by both police officers and laypersons before EMS arrival. Of utmost importance, rates of ROSC, 30-day survival and favourable neurological outcome proved to be not influenced by off-hours.

Data of the present investigation mirror a continuous excellent quality of ALS measures and therefore favourable patient outcome after OHCA in the Viennese area.

Conflicts of interest

The authors declare that they do not have any conflict of interest.

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