



HEALTH PROMOTION

Spring, it's time to ROSC

GIUSEPPE STIRPARO¹, AIDA ANDREASSI², GIUSEPPE MARIA SECHI², CARLO SIGNORELLI¹¹ Faculty of Medicine, School of Public Health, University of Vita-Salute San Raffaele, Milano, Italy;² Agenzia Regionale Emergenza Urgenza Headquarters (AREU HQ), Milano, Italy

Keywords

Resuscitation • Emergency medical system • Environmental pollution

Summary

Out-hospital cardiac arrest (OHCA) is a multi-factor disease. Many studies have correlated OHCA with a patient's lifestyle; unfortunately, less evidence highlights the correlation with meteorological factors. Methods: Analysis of 23959 OHCA rescue performed by the emergency medical system (EMS) of Lombardy Region, the most Italian populated region, in 2018 and 2019, the pre-pandemic era through a retrospective observational cohort study. The aim of the study consists on evaluating the probability of Return Of Spontaneous Circulation (ROSC) during months to highlight potential seasonal impact in ROSC achievement. In March and April, we highlight an increase of ROSC (OR: 1.20 95% CI 1.04-1.31; $p < 0.001$) compared to other months. During March and April, we highlight an increase of public access defibrillation (PAD) (3.5% vs 2.5%; $p < 0.001$), and a reduction

of overage time of first vehicle on scene (11.5 vs 11.8; $p < 0.001$) and age of patient (73.5 vs 74.2; $p < 0.01$). Finally, we highlight a slight reduction of cancer patient (1.6% vs 1.1%; $p = 0.01$). We didn't register significant differences in the other variables analyzed as: onset place, sex, rescue team and the patient's death before the rescue arrive. We highlight a difference in ROSC probability during the first month of spring. We register few differences in patient characteristics and EMS rescue, though just PAD use and age clinically impact OHCA patients. In this study, we are unable to fully understand the modification of the probability of ROSC in these months. Even though four variables have a statistically significant difference, they can't fully explain this modification. Different variables like meteorological and seasonal factor must be considered. We propose more research on this item.

Introduction

Out Hospital Cardiac arrest (OHCA), which is the cessation of cardiac mechanical activity in a person outside of a hospital setting, is a severe event with a high incidence (50 to 120 per 100.000 people) and a low survival rate worldwide (7%) [1]. Return of spontaneous circulation (ROSC) is correlated to many demographic variables [2, 3], like time of the Emergency medical system (EMS) rescue [4], layperson training [5, 6] and the protocol used by EMS [7, 8].

Environmental factors could modify the ROSC rate [9, 10]. Although little evidence has been published, that's why is challenging to find a clear correlation between the high number of environmental variables and OHCA.

Unfortunately, in the last three years, the research in the medical emergency was focused on Covid impact [11, 12] and the modification of EMS [11] and the collateral damage of COVID [13-17]. We highlight plenty of research focused on OHCA epidemiology, COVID [18-21] and other clinical aspects [22].

Despite some evidence correlating the meteorological factors and air pollutants with the incidence of OHCA [22-24], an increase of PM_{2.5} and average temperature are correlated with a rise in daily OHCA [23, 25].

Lombardy is the largest Italian region, with 9.96 million inhabitants and an area of 23 863 km². All missions are coordinated by a single Regional Agency, AREU, which coordinates the rescue through wheeled vehicles or

helicopters. AREU's techniques processed about 1 million calls in one years and in 800.000 call a vehicle was sent to rescue the patient AREU consist of 265 ambulances with a crew of 2-3 rescuers, 50 Intermediate Rescue Vehicles with a nurse, 59 Advanced Rescue Vehicles and 5 helicopters [26], nurse and doctor are trained by ACLS course [27-28]. All mission data are record in one single register, call EmMa (Emergency Management) [29].

The aim of the study consists on analyzing the impact during months of ROSC achievement, to highlight a potential seasonal link with meteorological factors.

Methods

STUDY DESIGN

The study is a retrospective observational cohort, it was conducted following the principles of the Helsinki declaration and was approved by the AREU Data Protection Officer in July 2022.

The Lombardy AREU headquarters register provided data analysis. The data analysis process was conducted employing the SAS-AREU portal. The portal contains all data regarding emergency calls, and the scenarios involving OHCA were selected.

The monthly diagnoses of OHCA in two years, from 1 January 2018 to 31 December 2019, was selected in SAS-AREU Database.

DATA

We used fourteen variables registered in the SAS-AREU database. The correlation between variables and ROSC was controlled in previous research. The variables were sex, age, timing of rescue, the onset of the event, type of rescue time and signs of death.

Data are available on AREU website. It is possible to find "OHCA" records in the SAS-AREU portal. The portal contains all the data related to emergency calls; it has been selected all the scenarios involving OHCA.

At every 118 call, performed in Lombardy Region, the EMS receiver automatically opens a record in SAS-AREU, the caller introduces the demographic characteristics and information about the main clinical problem of the patient. In case of OHCA patients, MSB (basic life support vehicle) and an MSA (advanced cardiovascular vehicle) are sent to the scene. The vehicle has a GPS tracker, and an automatic system which records the timing of rescue. During the rescue procedure, the MSB or MSA operator informs the medical director of the operation center with all other information to define the clinical status of the patient and the correct hospital. All data are correctly recorded in the SAS-AREU database. All data are necessary to identify the appropriate hospital Hub, while the GPS tracker automatically records logistic data.

STATISTICAL EVALUATION

We compared the characteristic of rescue in April and March with other months of the year in 2018 and 2019. The categorical variables are presented as numbers and percentage, and the continuous variables are presented as mean and standard deviation (SD). The categorical variables were analyzed by Z test for proportion and Odds Ratio (OR) with relative Confidence interval (CI) 95%. Continuous variables were tested for normality by means of the Kolmogorov-Smirnov test and the appropriate analysis for Z test for means. Differences were considered significant when $p < 0.05$. Otherwise, they were considered non-significant (NS). The Prism 8.0.1 statistical software (GraphPad Software LLC, San Diego, CA, USA) was used for this aim.

Results

A total of 23959 OHCA were analyzed, all event occurred in Lombardy region in the two years of analyses. 11663 (48.7%) was rescue by EMS in 2018 and 12296 (51.3%) was rescue in 2019.

Table I summarizes the comparison of rescues during March and April in 2018 and 2019 compared to all other months in 2018 and 2019. The average age (73.5 vs 74.2; $p = 0.01$) and the time of the first vehicle on scene (11.8 vs 11.5; $p = 0.0006$) in March and April were significant low than other months.

No difference was highlight in the overage time of hospital arrival.

Table II shows the analyzed ROSC variables. The significant differences are recorded for the use of the

Pads, which is greater during the spring (3.5% vs 2.5%; $p = 0.0005$), and there is also a reduction in OHCA for patients diagnosed with neoplastic disease (1.6% vs 1.1%; $p = 0.01$).

Figure 1 shows the percentage of ROSC on the total of OHCA; there is an increase in the months of March and April compared to the other months of the year. The value reaches 9.2% in March and 10.3% in April. In the two months, in the years of follow-up, the ROSC significant increased (OR: 1.20 95% CI 1.04-1.31; $p < 0.001$).

Noteworthy, four variables have a significant difference in the months of March and April. The most relevant was a major use of PAD OR 1.38 (CI 95% 1.14-1.67; $p < 0.001$) and the reduction of the average time of the first vehicle on scene (11.8 vs 11.5; $p < 0.001$), average age (73.5 vs 74.2; $p = 0.01$) and a slight reduction of cancer patient (1.6% vs 1.1%; $p = 0.01$).

Discussion

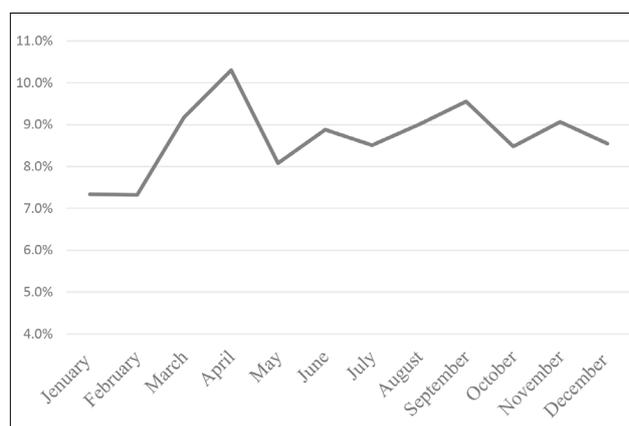
In accordance with the aim, we analyzed the ROSC in different months over the two years. We highlight an increase in ROSC during March and April in 2018 and 2019, as shown in Figure 1.

We analyzed 14 variables, all registered in AREU's database, as shown in Table I and Table II. All 14 variables, as evidenced in previous research, by McNally B. et al. [29], are correlated with the probability of ROSC.

Despite the statistical significance of the four variables, just the use of PAD and the average age of the patient have the major clinical impact, in fact, the other two variables, first ambulance on scene and percentage of oncology patients, were lightly changed, and the impact on ROSC was irrelevant.

Furthermore, could be difficult interpret as the increase of ROSC in the first month of spring. In fact, there wasn't a reason for the reduction of average age, maybe meteorological and seasonal factors could alter the epidemiology of OHCA how highlight by Kim JH et al [23], but more research must be implemented on

Fig. 1. Percentage of ROSC on total of monthly OHCA in 2018 and 2019.



Tab. I. Comparison of overage age and overage time of rescue.

	2018-2019	March-April	p-value
Age (SD)	74.2 (16.6)	73.5 (16.5)	< 0.01
Overage time of First vehicle (SD)	11.8 (6.5)	11.5 (5.3)	< 0.01
Overage Time hospital arrived (SD)	53.2 (24.3)	52.4 (22.6)	0.046

Tab. II. Demographic variables.

	2018-2019 Without March-April N (%)	2018-2019 March-April N (%)	p-value
Number of OHCA	20038 (80.4%)	3921 (19.6%)	
ROSC	1686 (8.4%)	380 (9.7%)	< 0.01
Female	7811 (39.0%)	1526 (38.9%)	0.47
RCP layperson	4320 (21.6%)	876 (22.3%)	0.14
PAD	509 (2.5%)	136 (3.5%)	< 0.001
no MSI	16991 (84.8%)	3338 (85.1%)	0.29
no MSA	7951 (39.7%)	1546 (39.4%)	0.38
Death people	2793 (13.9%)	516 (13.2%)	0.10
Workplace	914 (4.6%)	190 (4.9%)	0.22
Open place	1010 (5.0%)	203 (5.2%)	0.36
Traumatic event	1377 (6.9%)	284 (7.2%)	0.20
Neoplastic patient	313 (1.6%)	43 (1.1%)	0.01

PAD: Public access defibrillation; MSI: Vehicle with a Nurse; MSA: Vehicle with a doctor and a nurse; Death people: a person with clear sign of death (i.e. Decapitation).

this topic for coordinate new public health project to increase ROSC.

No less significant is the increase of PAD's use; in fact, during the spring season, we didn't register a modification of OHCA location, no significant modification was registered in the workplace or in a closed place area, where the number of mandatory PAD is high. This point should be the focus of future research. In fact, we must identify a reason for this phenomenon to achieve the possibility of increasing the use of Pad in OHCA.

Different factors, including environmental ones, can cause OHCA, often they are unknown, and the scientific community should reconsider those issues related to OHCA epidemiology. Great attention has been paid to COVID-19 and OHCA reports in recent years, but it is necessary to take a step back and analyze the pre-pandemic data in order to study the environmental factors that may contribute to OHCA.

This study adds two key aspects to OHCA's research. The first aspect consists in changing the focus of COVID-19 impact on OHCA epidemiology, and reconsidering the pre pandemic issues, like the influence of external factors, or the meteorological impact on the ROSC. The second aspect concerns a legislative matter. As a matter of fact, after the Italian Legislative degree (D Lgs 81/08), D Lgs 158/12 and D Lgs 116/21, the ROSC study became important to highlight the impact of this law on OHCA's patient outcome. The implication of the seasonal correlation between OHCA and ROSC should be investigated in order to highlight the possible link with pollution or other events unknown in this research. The research on OHCA during spring season might underline a difference in the rescue condition or

the clinical characteristic of the patient, which can help future policy.

Conclusion

During the first month of spring, we measured an increase in ROSC probability in the Lombardy region. This phenomenon is correlated with the increasing in Pads used by the layperson and a reduction of the arriving time of the first vehicle on scene. However, this change could not completely justify the ROSC increase. Seasonal or meteorological phenomena could influence OHCA epidemiology.

The study of the phenomenon is an important public health's concern. In fact, a deep analysis of clinical patients, or meteorological factors could highlight new variables for the ROSC achievement in patients affected by OHCA. The second study's aim is to bring attention back to the pre COVID-19 pandemic types of studies, and the impact of the environment on the development of the disease in addition to COVID-19.

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Conflict of interest statement

All authors declare no conflicts of interest.

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Authors' contributions

GS, CS and GMS conceived and designed the study. GS, AA collected and analyzed the data. GS drafted the first version of the manuscript. All authors edited, revised the manuscript, and approved the final version before submission.

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Correspondence: Giuseppe Stirparo, Agenzia Regionale Emergenza Urgenza Headquarters (AREU HQ), Via Campanini 6, 20124, Milano (MI), Italia. Tel. 0267129001 - E-mail: g.stirparo@areu.lombardia.it

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