Safety and Health at Work 14 (2023) 131–134

Contents lists available at ScienceDirect

Safety and Health at Work

journal homepage: www.e-shaw.net

Short Communication

Cardiac Arrest Management in the Workplace: Improving but Not Enough?

Alexis Descatha [1,2], François Morin [3], Marc Fadel [1,*], Thomas Bizouard [3], Romain Mermillod-Blondin [4], Julien Turk [5], Alexandre Armaingaud [4,6], Hélène Duhem [7], Dominique Savary [1,3]

[1] Univ Angers, CHU Angers, Univ Rennes, Inserm, EHESP, Irset (Institut de Recherche en Santé, Environnement et Travail) - UMR_S 1085, IRSET-ESTER, SFR ICAT, CAPTV CDC, F-49000, Angers, France
[2] Department of Occupational Medicine, Epidemiology and Prevention, Northwell Health Hofstra, New York, USA
[3] Emergency Department, Angers University Hospital, Angers, France
[4] SAMU 74, Emergency Department, General Hospital, Annecy, France
[5] SAMU 73, Emergency Department, General Hospital, Chambéry, France
[6] Northern French Alps Emergency Network, General Hospital, Annecy, France
[7] University Grenoble Alps/CNRS/CHU de Grenoble Alpes/TIMC-IMAG UMR 5525, Grenoble, France

ARTICLE INFO

Article history:
Received 17 August 2022
Received in revised form
16 December 2022
Accepted 30 December 2022
Available online 4 January 2023

Keywords:
cardiac arrest
location
occupational
public health
work

ABSTRACT

The aim was to describe out-of-hospital cardiac arrest (OHCA) occurring in the workplace of a large emergency network, and compare the evolution of their management in the last 15 years. A retrospective study based on data from the Northern Alps Emergency Network compared characteristics of OHCA between cases in and out the workplace, and between cases occurring from January 2004 to December 2010 and from January 2011 to December 2017. Among the 15,320 OHCA cases included, 320 occurred in the workplace (2.1%). They were more often in younger men, and happened more frequently in an area with access to public defibrillation, had more often a shockable rhythm, had a cardiopulmonary resuscitation started by a bystander more frequently, and had a better outcome. Cardiopulmonary resuscitation started by a bystander was the only chain of survival link that improved for cases occurring after December 2010. Workplace OHCA seems to be managed more effectively than others; however, only a slight survival improvement was observed, suggesting that progress is still needed.

Out-of-hospital cardiac arrest (OHCA) remains a leading cause of mortality among adults in the world [1]. Many improvements of the OHCA management have been made in the last two decades [2]. However, the overall prognosis and neurological outcomes are relatively poor following OHCA, with few improvements during the past three decades [3], though these outcomes have improved for in-hospital cardiac arrest cases [4].

Although OHCA cases in the workplace are rare, they have singularities compared to other locations in terms of population and chain of survival [5,6]. OHCA in occupational settings are associated with a better immediate prognosis than OHCA cases occurring elsewhere, and the number of years of life saved is generally high because of the age of the victims. However, even though some studies have focused on workplace location management and outcomes [7–11], the evolution of OHCA management in the last 15 years is yet to be evaluated.

After describing OHCA cases occurring in the workplace of a large emergency network, we aimed to analyze the evolution of the management of OHCA in the last 15 years.

An observational, retrospective study was conducted using data of all OHCA cases collected from the Northern French Alps

Alexis Descatha: https://orcid.org/0000-0001-6028-3186; François Morin: https://orcid.org/0000-0002-1582-2934; Marc Fadel: https://orcid.org/0000-0002-1554-0021; Thomas Bizouard: https://orcid.org/0000-0002-2974-9192; Romain Mermillod-Blondin: https://orcid.org/0000-0003-4818-7321; Julien Turk: https://orcid.org/0000-0001-7128-8281; Alexandre Armaingaud: https://orcid.org/0000-0002-9103-6695; Hélène Duhem: https://orcid.org/0000-0001-5272-5992; Dominique Savary: https://orcid.org/0000-0001-8480-5348
* Corresponding author. Univ Angers, CHU Angers, Univ Rennes, Inserm, EHESP, Irset (Institut de recherche en santé, environnement et travail) – UMR_S 1085, SFR ICAT, CAPTV CDC, F-49000, Angers, France.
E-mail address: marc.fadel@univ-angers.fr (M. Fadel).

2093-7911/$ – see front matter
https://doi.org/10.1016/j.shaw.2022.12.004

Emergency Network from January 2004 to December 2017. A focus on the location of cardiac arrest (workplace or not) and on the evolution of collected variables was made. The Northern French Alps Emergency Network is formed by all the hospitals in three counties (Isère, Savoie, and Haute-Savoie), including 13 Mobile Emergency, and Resuscitation Services. This network allows to collect data for the cardiac arrest registry of the Northern French Alps (RENAU AC), which is an exhaustive registry that follows the Utstein Style, and is set in a mountain area [12,13]. Since the first of January 2004, each out-of-hospital cardiac arrest case has been recorded in an electronic form completed by the emergency physician in charge of the patient, and the dispatch center.

Utstein relevant variables such as age (considered as continuous, and in four categories: 0–18 years, 18–40 years, 40–60 years, and 60 years and more), gender (male or female), presence of bystanders (yes or no), bystander cardiopulmonary resuscitation (CPR) (yes or no), location of the OHCA (workplace or not), shockable rhythm (yes or no), and intervention times were included. Patient status (alive/dead, and using standardized cerebral performance category [CPC] score) was obtained at Day 30 from the receiving unit, or via phone interviews with research associates, asking if hospital discharge had occurred. The survival rate included return of spontaneous circulation at scene, admitted alive at hospital, and survival at 30 days, with good neurological status (CPC 1 & 2).

The first part of the analysis was the comparison of the characteristic and survival of OHCA cases occurring in the workplace and those outside of the workplace. For this, χ^2 tests were used for the comparison of percentage. The second part of the analysis consisted in the assessment of the evolution of OHCA in the workplace during the study period. For this, cases were categorized into two 7-year periods: the period from January 2011 to December 2017 was compared to a reference period starting from January 2004 to December 2010. Likely, appropriate bivariate analyses comparing the characteristics of OHCA occurring in the most recent period to the reference period were carried out. Adjusted logistic models assessing the risk of three survival outcomes, with the period of occurrence of OHCA, were computed. Statistical analyses were all performed using SAS (Statistical Analysis Software, v. 9.4 SAS Institute Inc., Cary, NC, USA). A *p-value* of <0.05 was considered statistically significant. The study complied with the Declaration of Helsinki, and was approved by the ethics committee of the University Hospital of Clermont-Ferrand, Clermont-Ferrand, France (IEC no. 5891). The RENAU AC registry, including the method of

Table 1
Description of the sample with comparison of all OHCA and OHCA occurring in the workplace

	Total OHCA	Number of OHCA in the workplace (% of total OHCA)	Number of OHCA out of the workplace (% of total OHCA)	*p-value*
Sex				
Women	4635	29 (0.6%)	4606 (99.4%)	(Reference)
Men	10779	291 (2.7%)	10488 (97.3%)	<.0001
Age				
0-18 years	352	0 (0%)	352 (100%)	ns
18-40 years	1288	60 (4.7%)	1228 (95.3%)	(Reference)
40-60 years	3716	209 (5.6%)	3507 (94.4%)	ns
≥60 years	10059	51 (0.5%)	10008 (99.5%)	<.0001
Witness				
No	4051	75 (1.9%)	3976 (98.1%)	(Reference)
Yes	11223	244 (2.2%)	10979 (97.8%)	ns
Etiology				
Non cardiac	5373	124 (2.3%)	5249 (97.7%)	(Reference)
cardiac	10035	196 (2.0%)	9839 (98%)	ns
Public access defibrillation				
No	12137	236 (1.9%)	11901 (98.1%)	(Reference)
Yes	205	11 (5.4%)	194 (94.6%)	0.0009
Shockable rhythm				
No	12117	204 (1.7%)	11913 (98.3%)	(Reference)
Yes	3119	115 (3.7%)	3004 (96.3%)	<.0001
Bystander cardiopulmonary resuscitation				
No	10562	201 (1.9%)	10361 (98.1%)	(Reference)
Yes	4318	116 (2.7%)	4202 (97.3%)	0.0028
Return of spontaneous circulation				
No	10498	192 (1.8%)	10306 (98.2%)	(Reference)
Yes	4136	124 (3.0%)	4012 (97%)	<.0001
Admitted hospital alive				
No	11482	208 (1.8%)	11274 (98.2%)	(Reference)
Yes	3151	108 (3.4%)	3043 (96.6%)	<.0001
Survival at day 30 with good neurological outcome				
No	13707	272 (2.0%)	13435 (98%)	(Reference)
Yes	904	43 (4.8%)	861 (95.2%)	<.0001
Period				
2004-2010	7040	154 (2.2%)	6886 (97.8%)	(Reference)
2011-2017	8375	166 (2.0%)	8209 (98%)	ns

NS = $p \geq 0.05$.

monitoring patient survival, was also validated by the appropriate ethic committee.

Between 2004 and 2017, 15,320 OHCA cases that had a location reported were included. Among them, 320 cases occurred in the workplace (2.1%). OHCA cases occurring in the workplace were more often men, younger, happened more frequently in an area with access to public defibrillation, had more often a shockable rhythm, had a CPR started by a bystander more frequently, and had a better outcome (Table 1).

The comparing data of the recent seven years period to the reference period highlighted that having a CPR started by a bystander was the only chain of survival improved (Table 2). Indeed, CPR was started by a bystander in approximatively 46% or more cases in the most recent period compared to the reference period. Though the rates of return of spontaneous circulation at scene and admitted alive at a hospital were not statistically different, survival at 30 days with good neurological status (CPC 1 & 2) was better: 67.4% cases had good neurological outcome in the most recent period compared to 32.6% of cases in the reference period.

Adjusted logistic analyses confirmed the previous results, and found statistically better survival outcomes for both the place of occurrence and period of occurrence, with adjusted odds ratio ranging from 1.29 (95% CI, 1.17-1.42) to 2.00 (95% CI, 1.67-2.40).

OHCA in the workplace appears to be managed more effectively than OHCA occurring in other places, which encourages setting up first-aid programs in certain companies [14]. However, there is only a slight survival improvement in the management of OHCA at the workplace, with higher rate of cardiopulmonary resuscitation started by a bystander, leaving room for significant improvements.

OHCA in the workplace is a rare event that represents between 1 and 10% of all OHCA cases. In most studies, the workplace is one of the least frequent sites of OHCA [5,15–18], regardless of the type of workplace [19]. Nevertheless, the number of years of life saved is generally high, and some authors, including us, have found that patients experiencing OHCA in the workplace presented one of the highest hospital discharge survival rates [5,6,18]. Indeed, OHCA tends to occur in young people, and the survival chain is better than elsewhere [5,18]. This points out the importance of continuing to improve the management of OHCA occurring in the workplace.

Different limitations should be discussed. First, we used the Northern French Alps Emergency Network with the RENAU OHCA. It is not a nationwide register, but the proportion of OHCA and survival is similar to the previous data from a national register [11], with a good exhaustivity [13]. The quality of data since 2004 and its

Table 2
Comparison of OHCA occurring in the workplace in the first period and the second period

	Total OHCA in the workplace	Number of OHCA in the workplace 2004-2010 (% of total OHCA)	Percentage of OHCA in the workplace out of all OHCA occurring between 2004-2010	Number of OHCA in the workplace 2011-2017 (% of total OHCA)	Percentage of OHCA in the workplace out of all OHCA occurring between 2011-2017	*p*-value
Sex						
Women	29	14 (48.3%)	9.1%	15 (51.7%)	9.0%	(Reference)
Men	291	140 (48.1%)	90.9%	151 (51.9%)	91.0%	ns
Age						
18-40 years	60	31 (51.7%)	20.1%	29 (48.3%)	17.0%	(Reference)
40-60 years	209	106 (50.7%)	68.8%	103 (49.3%)	62.0%	ns
≥60 years	51	17 (33.3%)	11.1%	34 (66.7%)	21.0%	ns
Witness						
No	75	40 (53.3%)	26.0%	35 (46.7%)	21.2%	(Reference)
Yes	244	114 (46.7%)	74.0%	130 (53.3%)	78.8%	ns
Etiology						
Non cardiac	124	56 (45.2%)	36.4%	68 (54.8%)	41.0%	(Reference)
cardiac	196	98 (50.0%)	63.6%	98 (50.0%)	59.0%	ns
Public access defibrillation						
No	236	79 (33.5%)	96,3%	157 (66.5%)	95.2%	(Reference)
Yes	11	3 (27.3%)	3.7%	8 (72.7%)	4.8%	ns
Shockable rhythm						
No	204	104 (51.0%)	67.5%	100 (49.0%)	61.0%	(Reference)
Yes	115	50 (43.5%)	32.5%	65 (56.5%)	39.0%	ns
Bystander cardiopulmonary resuscitation						
No	201	107 (53.2%)	69.5%	94 (46.8%)	57.7%	(Reference)
Yes	116	47 (40.5%)	30.5%	69 (59.5%)	42.3%	0.03
Return of spontaneous circulation						
No	192	99 (51.6%)	64.3%	93 (48.4%)	57.4%	(Reference)
Yes	124	55 (44.4%)	35.7%	69 (55.7%)	42.6%	ns
Admitted hospital alive						
No	208	107 (51.4%)	69,5%	101 (48.6%)	62.3%	(Reference)
Yes	108	47 (43.5%)	30.5%	61 (56.5%)	37.7%	ns
Survival at day 30 with good neurological outcome						
No	272	140 (51.5%)	90.9%	132 (48.5%)	82.0%	(Reference)
Yes	43	14 (32.6%)	9.1%	29 (67.4%)	18.0%	0.02

NS = $p \geq 0.05$.

stability allowed comparison of different periods of time [20], with improved location coding over time. Second, the definition of "workplace" can be ambiguous. There is a large heterogeneity of workplaces, from small shop to large offices, and now including home teleworking. However, a global comparison is possible, considering the overall public health aim. Third, it was only possible to compare data before the COVID pandemic, and not the recent ones. Indeed, we know that the COVID pandemic will have major consequences on OHCA, but it will need to wait to have stabilized and clean data.

With the many efforts in many countries of emergency specialists and occupational and public health practitioners, our results showed that the management of OHCA occurring in the workplace has improved, but pursuing efforts to allow better outcomes is needed, which emphasizes on the importance of continuing this global prevention task.

Conflict of interest

Authors are paid by their institution; AD is also paid as editor of the *Archives des Maladies professionnelles et de l'Environnement* (*Elsevier*).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2022.12.004.

References

[1] Perkins GD, Graesner J-T, Semeraro F, Olasveengen T, Soar J, Lott C, et al. European resuscitation council guidelines 2021: executive summary. Resuscitation 2021;161:1–60. https://doi.org/10.1016/j.resuscitation.2021.02.003.

[2] Nolan JP, Soar J, Perkins GD. Cardiopulmonary resuscitation. BMJ 2012;345. https://doi.org/10.1136/bmj.e6122. e6122–e6122.

[3] Myat A, Song K-J, Rea T. Out-of-hospital cardiac arrest: current concepts. The Lancet 2018;391:970–9. https://doi.org/10.1016/s0140-6736(18)30472-0.

[4] Girotra S, Nallamothu BK, Spertus JA, Li Y, Krumholz HM, Chan PS, et al. Trends in survival after in-hospital cardiac arrest. N Engl J Med 2012;367:1912–20. https://doi.org/10.1056/NEJMoa1109148.

[5] Descatha A, Dagrenat C, Cassan P, Jost D, Loeb T, Baer M. Cardiac arrest in the workplace and its outcome: a systematic review and meta-analysis. Resuscitation 2015;96:30–6. https://doi.org/10.1016/j.resuscitation.2015.07.004.

[6] Descatha A, Frederic M, Devere C, Dolveck F, Goddet S, Baer M, et al. Details of the initial management of cardiac arrest occurring in the workplace in a French urban area. Resuscitation 2005;65:301–7. https://doi.org/10.1016/j.resuscitation.2004.12.010.

[7] Mayr NP, Mayr T, Tassani P, Martin K. Use of automated external defibrillators in the occupational setting in Germany. J Occup Environ Med 2012;54:789–91. https://doi.org/10.1097/jom.0b013e318256f65c.

[8] Shibahashi K, Sugiyama K, Kuwahara Y, Ishida T, Sakurai A, Kitamura N, et al. Private residence as a location of cardiac arrest may have a deleterious effect on the outcomes of out-of-hospital cardiac arrest in patients with an initial non-shockable cardiac rhythm: a multicentre retrospective cohort study. Resuscitation 2020;150:80–9. https://doi.org/10.1016/j.resuscitation.2020.01.041.

[9] Verbrugghe M, De Ridder M, Kalaai M, Mortelmans K, Calle P, Braeckman L. Presence and use of automated external defibrillators in occupational setting, Belgium. Int J Occup Med Environ Health 2018. https://doi.org/10.13075/ijomeh.1896.01169.

[10] Kilaru AS, Leffer M, Perkner J, Sawyer KF, Jolley CE, Nadkarni LD, et al. Use of automated external defibrillators in US federal buildings: implementation of the Federal Occupational Health public access defibrillation program. J Occup Environ Med 2014;56:86–91. https://doi.org/10.1097/JOM.0000000000000042.

[11] Descatha A, Rigot H, Ursat C, Baer M, Loeb T. Cardiac arrest in the workplace: pilot study on the RéAC register. Resuscitation 2013;84:e65–6. https://doi.org/10.1016/j.resuscitation.2013.02.012.

[12] Ageron F-X, Debaty G, Gayet-Ageron A, Belle L, Gaillard A, Monnet M-F, et al. Impact of an emergency medical dispatch system on survival from out-of-hospital cardiac arrest: a population-based study. Scand J Trauma Resusc Emerg Med 2016;24:53. https://doi.org/10.1186/s13049-016-0247-y. 53.

[13] Savary D, Ricard C, Drouet A, Gaillard A, Geri G, Fadel M, et al. How exhaustive are out of hospital cardiac arrest registers? The example of the Northern French Alps Cardiac Arrest Registry. Resuscitation 2020;148:57–8. https://doi.org/10.1016/j.resuscitation.2020.01.002.

[14] Starr LM. Automated external defibrillation in the occupational setting. J Occup Environ Med 2002;44:2–7. https://doi.org/10.1097/00043764-200201000-00002.

[15] Engdahl J, Herlitz J. Localization of out-of-hospital cardiac arrest in Göteborg 1994–2002 and implications for public access defibrillation. Resuscitation 2005;64:171–5. https://doi.org/10.1016/j.resuscitation.2004.08.006.

[16] Reed DB, Birnbaum A, Brown LH, O'Connor RE, Fleg JL, Peberdy MA, et al. Location of cardiac arrests in the public access defibrillation trial. Prehospital Emergency Care 2006;10:61–7. https://doi.org/10.1080/10903120500366128.

[17] Rudner R, Jalowiecki P, Karpel E, Dziurdzik P, Alberski B, Kawecki P. Survival after out-of-hospital cardiac arrests in Katowice (Poland): outcome report according to the "Utstein style.". Resuscitation 2004;61:315–25. https://doi.org/10.1016/j.resuscitation.2004.01.020.

[18] Muraoka H, Ohishi Y, Hazui H, Negoro N, Murai M, Kawakami M, et al. Location of out-of-hospital cardiac arrests in takatsuki city where should automated external defibrillator be placed? Circulation J 2006;70:827–31. https://doi.org/10.1253/circj.70.827.

[19] Palaghita A, Jost D, Despreaux T, Bougouin W, Beganton F, Loeb T, et al. Characteristics of cardiac arrest occurring in the workplace. Journal of Occup Environ Med 2016;58:747–52. https://doi.org/10.1097/jom.0000000000000783.

[20] Savary D, Douillet D, Morin F, Drouet A, Moumned T, Metton P, et al. Acting on the potentially reversible causes of traumatic cardiac arrest: possible but not sufficient. Resuscitation 2021;165:8–13. https://doi.org/10.1016/j.resuscitation.2021.05.012.