Research

Assessment of dispatch-assisted cardiopulmonary resuscitation performance during out-of-hospital cardiac arrest in a Tuscan emergency operation center: a retrospective study

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Abstract

Background: Time is the most crucial prognostic factor in out-of-hospital cardiac arrest (OHCA) owing to its clinical features. Dispatcher-assisted CPR (DA-CPR) by dispatch centers to a bystander calling for an ambulance, enabling even an inexperienced bystander to start CPR in 50% of cases and reducing the free therapy interval from chest compression to less than three minutes.

Objectives: to assess the dispatch-assisted cardiopulmonary resuscitation performance during out-of-hospital cardiac arrest.

Methods: a retrospective study was conducted at the Firenze-Prato Emergency Operation Centre to analyse data collected from all dispatch audio recordings of OHCA events that occurred between 1 January 2019 and 31 December 2020. Emergency calls lasting less than 60 s were excluded from the analysis, as this duration does not provide dispatchers with adequate time to accurately identify OHCA and provide pre-arrival instructions to the bystander.

Results: A total of 1,267 OHCAs cases were included in this study, with 832 (65.7%) occurring in 2019 and 435 (34.3%) in 2020. Emergency nurses offered pre-arrival instructions in 272 cases (21.5%), with 160 cases in 2019 (19.2%) and 112 cases (25.7%) in 2020 (χ^2=7.19, p=0.007). These instructions were accepted by the caller in 9% (n=75) and 14% (n=61) of the cases, respectively (χ^2=7.48, p=0.006). OHCA events that could not be identified by telephone (therefore, DA-CPR was not possible) were 365 cases (43.9%) in 2019 and 175 cases (40.2%) in 2020 (χ^2=1.55, p=0.213).
Conclusions: The adoption of a standardised protocol for delivering pre-arrival instructions, along with training programs focusing on OHCA and interview techniques, is strongly recommended based on the findings of our study. This was reinforced by the analysis of nighttime calls during which DA-CPR was not provided, including cases without clear justification.

Keyword: Emergency, Nurses, Cardiopulmonary Resuscitation, Pre-Arrival Instructions, Outcome.

Background

Time is the most crucial prognostic factor in out-of-hospital cardiac arrest (OHCA) owing to its clinical features. In fact, the delay in effective cardiopulmonary resuscitation (CPR), leads to a sudden and progressive reduction in the survival rate, despite the application of advanced life support measures such as defibrillation, drug administration, the resolution of the potential triggering causes[1]. Emergency medical dispatchers can provide CPR instructions to a bystander calling for an ambulance, enabling even an inexperienced bystander to start CPR in 50% of cases and reducing the free therapy interval from chest compression to less than three minutes[2]. Despite nationwide recommendations encouraging the implementation of standardized criteria for early recognition of OHCA and the delivery of dispatcher-assisted CPR (DA-CPR) by dispatch centers, no quality standards have been established yet[3,4]. Additionally, dispatcher education programs are managed by emergency services without a common framework, resulting in significant differences between each emergency center in the management of OHCA and performance analysis[5].

To ensure early, high-quality pre-arrival instructions, both the service and dispatcher must recognise that expertise in DA-CPR represents a tool for providing quality care, which should be acquired and maintained through training and ongoing sessions. A similar situation can be observed internationally[6], where emergency protocols do not refer to a single guideline. The dispatchers can be medical or technical personnel. For example, in US 911 operations centres, trained lay telecommunicators work, whereas in Europe, emergency nurses are widely involved[7,8].

With the aim to assess the dispatch-assisted cardiopulmonary resuscitation performance during out-of-hospital cardiac arrest, a retrospective study was conducted at the Firenze-Prato Emergency Operation Centre. The primary objective was to evaluate nurses' performance regarding DA-CPR in OHCA cases. The secondary objectives were to uncover the factors that may have impaired the dispatcher's ability to identify the signs of an OHCA, understand the rationale behind the dispatcher's failure to provide pre-arrival instructions to the bystander, and identify the circumstances that hindered the initiation of resuscitation efforts.

Methods

Study design

We conducted a retrospective descriptive study to analyse data from both 2019 and 2020, aiming to identify significant differences in the studied issue, between the pre-COVID-19 era and the initial period of the pandemic. The trends were evaluated during this analysis. It is important to note that in December 2020, the Florence-Prato Emergency Dispatch Center transitioned to a public safety answering point (PSAP). However, this organizational change was not further explored in this study.

Population and setting

We collected and reviewed all dispatch audio recordings of OHCA events that occurred between 1 January 2019 and 31 December 2020.

We included all OHCA cases in the Florence-Prato Emergency Dispatch Center database and audio recordings. The dispatcher was considered to have provided CPR instructions if the emergency nurse commented during the recording, indicating suspicion of OHCA, such as stating, "*We need to do CPR*". The effective provision of DA-CPR was determined when the bystander began counting compressions aloud or when the dispatcher initiated counting once the rescuer was ready to start.

Emergency calls lasting less than 60 s were excluded from the analysis, as this duration does not provide dispatchers with adequate time to accurately identify OHCA and provide pre-arrival instructions to the bystander. A summary of the exclusion criteria is shown in Table 1.

Table 1. – Study variables from re-entry data.

Re-entry data	Rationale
Emergency progressive code	Serial unique number composed of 4 characters for the reference year and of 12 characters for the progressive code of the emergency mission.
Location event code	Identifies the place where OHCA occurred (space or structure). Composed by one letter. □ K (home environment) □ S (street) □ P (offices or public places) □ Z (other places) □ Y (sport facilities) □ O (school environment) □ L (work setting)
Alleged pathology code	Identifies the code inherent the alleged pathology hypotized from the telephonic interview based on the main symptom declared. Composed by 3 characters. □ C01: traumatic □ C02: cardio-circulatory □ C03: respiratory □ C04: neurologic □ C05: psychiatric □ C06: neoplastic □ C07: intoxication □ C08: metabolic □ C09: gastro-intestinal □ C10: urologic □ C11: oculistic □ C12: otorhinolaryngology □ C13: dermatologic □ C14: obstetric-ginecological □ C15: infective □ C19: other pathology □ C20: Unidentified pathology
Severity code	Color code which refers to the presumed severity of the event. □ White: non-evolving intervention that could be post-posed, normal vital signs; □ Green: deferrable intervention, normal vital signs, potentially non-evolutive event; □ Yellow: non-deferrable intervention with a high evolutive potential and probable quick deterioration of vital conditions; □ Red: absolute emergency with the highest intervention priority for the immediate life risk, severe/absence of vital functions, lack of information.

Date/hour of the emergency call receiving	Temporal references of the emergency call (dd/mm/yyyy, h:min:sec).
Destination hospital	Reference center for the hospitalization of the victim.
Healthcare evaluation code	Numeric evaluation code attributed by the emergency équipe. □ Code 0: unnecessary intervention; □ Code 1: patient affected by a mild condition; □ Code 2: patient affected by a severe condition; □ Code 3: patient with a compromission of vital functions; □ Code 4: patient dead
Code of the rescue vehicle involved	Alphanumeric code to identify the rescue vehicle activated on the emergency
Interview time	Time measured in seconds inherent the duration of the interview between the dispatcher and the caller.
Total time	Interval of time measured in minutes from the answer to the emergency call and the "free of duty" declared by the rescue vehicle.
Free notes	Various annotations by the dispatcher.

Study variables and data collection

Data were analysed using the standardised OHCA evaluation template developed by Dami et al., 2018[9]. A summary of these data is presented in Table 1. Owing to the limitations of the management software used by the Emergency Dispatch Center (Engineering®), which is not configured for the registration of OHCA and pre-arrival instruction data, the details of resuscitation proposals and executions were collected by listening to audio recordings.

In cases involving multiple emergency vehicles responding to the same incident, resulting in multiple emergency sheets in the database, we considered only the data related to the most advanced vehicle activated during an emergency, such as a helicopter rescue, instead of an ambulance with lay personnel.

Statistical analysis

Data were anonymized by a researcher not involved in data extraction; subsequently data were analyzed according to their distribution, using measures of central tendency and position for the descriptive statistics. Parametric and non-parametric tests were used for inferential statistical analysis. Categorical data are presented as absolute frequencies and percentages using the chi-square test, when possible. Differences were considered statistically significant at $p < 0.05$.

Statistical analyses were performed using SPSS for Windows (version 14.0; SPSS Inc., Chicago, IL, USA).

Results

A total of 1,267 OHCAs cases were included in this study, with 832 (65.7%) occurring in 2019 and 435 (34.3%) in 2020. OHCA events occurred in various locations, as summarised in Table 1. Alleged pathology codes assigned to the OHCA cases are presented in Table 2. Data analysis was conducted following the model proposed by Dami et al., 2018[9], categorizing cases into external causes, organizational/professional causes, and caller circumstances.

Emergency personnel assigned codes three (severe mission of vital functions) and four (death) to 69 (7.8%) and 767 (92.2%) cases, respectively, in 2019, and 27 (6.2%) and 408 (93.8%) cases in 2020. The median duration of the emergency dispatch interviews was 63 seconds (interquartile range 34) in 2019 and 64 seconds (interquartile range 38) in 2020.

Emergency nurses offered pre-arrival instructions in 272 cases (21.5%), with 160 cases in 2019 (19.2%) and 112 cases (25.7%) in 2020 (χ^2=7.19, p=0.007). These instructions were accepted by the caller in 9% (n=75) and 14% (n=61) of the cases, respectively (χ^2=7.48, p=0.006). OHCA events that could not be identified by telephone (therefore, DA-CPR was not possible) were 365 cases (43.9%) in 2019 and 175 cases (40.2%) in 2020 (χ^2=1.55, p=0.213). The reasons for the absence of DA-CPR included the caller not being on site, OHCA occurring after the emergency call but before the arrival of emergency personnel, and the caller being too agitated to answer the nurses' questions regarding the victims' consciousness and breathing.

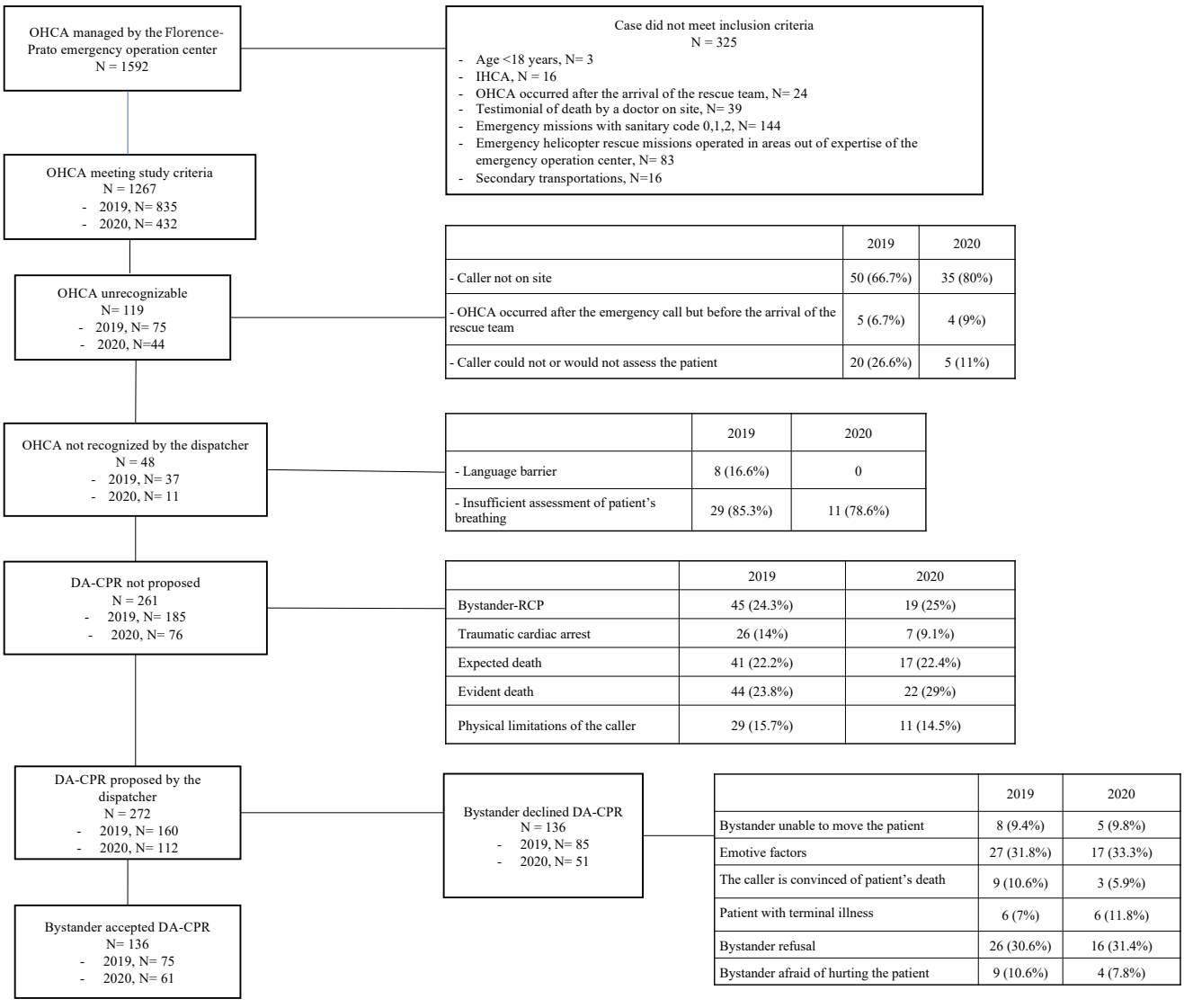
Pre-arrival instructions were not provided

because of the non-recognition of OHCA (n=48, 5%) in cases involving a language barrier with the caller (n=8, 14.7% in 2019 and n=0, 0% in 2020) and insufficient assessment of breathing (n=29, 85.3% in 2019 and n=11, 78.6% in 2020; χ^2=0.06, p=0.807). The latter aspect pertains to the inability of the operation centre nurse to determine gasping or abnormal breathing, and bystanders' inability to assess normal breathing. The proposal to start CPR was declined by the bystander in more than half of the cases (n=85, 53%) in 2019 and in 31.9% of cases (n=51) in 2020 (χ^2=14.78, p=0.001) (Figure 1).

Table 2. – OHCA location event codes of 2019 and 2020.

Location Event Code	2019 Year N = 832	2020 Year N = 435
K (home enviroment)	754 (91%)	401 (92%)
S (street)	52 (6.3%)	19 (4.4%)
P (offices or public places)	12 (1.4%)	6 (1.4%)
Z (other places)	10 (1.2%)	7 (1.6%)
Y (sport facilities)	2 (0.2%)	0 (0.0%)
Q (school enviroment)	1 (0.1%)	0 (0.0%)
L (work setting)	1 (0.1%)	2 (0.5%)

Figure 1. – Study recruitment conditions and the main endpoints.



	2019	2020
- Caller not on site	50 (66.7%)	35 (80%)
- OHCA occurred after the emergency call but before the arrival of the rescue team	5 (6.7%)	4 (9%)
- Caller could not or would not assess the patient	20 (26.6%)	5 (11%)

	2019	2020
- Language barrier	8 (16.6%)	0
- Insufficient assessment of patient's breathing	29 (85.3%)	11 (78.6%)

	2019	2020
Bystander-RCP	45 (24.3%)	19 (25%)
Traumatic cardiac arrest	26 (14%)	7 (9.1%)
Expected death	41 (22.2%)	17 (22.4%)
Evident death	44 (23.8%)	22 (29%)
Physical limitations of the caller	29 (15.7%)	11 (14.5%)

	2019	2020
Bystander unable to move the patient	8 (9.4%)	5 (9.8%)
Emotive factors	27 (31.8%)	17 (33.3%)
The caller is convinced of patient's death	9 (10.6%)	3 (5.9%)
Patient with terminal illness	6 (7%)	6 (11.8%)
Bystander refusal	26 (30.6%)	16 (31.4%)
Bystander afraid of hurting the patient	9 (10.6%)	4 (7.8%)

Discussion

Since their establishment, Emergency Medical Services have been consistently engaged in the challenge of reducing out-of-hospital mortality. Therefore, it is imperative to analyse OHCA as the "quintessential" emergency when considering performance monitoring within an Emergency Dispatch Center. Owing to the highly time-dependent nature of cardiac arrest, the dispatcher plays a pivotal role because it serves as a crucial link between the caller/bystander and the initiation of resuscitation efforts.

In recent years, global efforts have been made to enhance OHCA management. This improvement was made possible by the adoption of the latest guidelines by emergency personnel and a heightened focus on involving citizens as active and essential members of the survival chain. Despite the simplification of resuscitation procedures, with the proven efficacy of "hands-only" CPR, the percentage of bystander-initiated CPR remains insufficient[10].

To evaluate OHCAs managed by the Florence-Prato Emergency Dispatch Center, we considered all confirmed OHCA cases attended to by emergency personnel. The lack of data related to the delivery of DA-CPR needed a review of all OHCA emergency calls. Between 2019 and 2020, there was a 52% reduction in OHCA cases, declining from 832 (65.7%) in 2019 to nearly half (n=435, 34.3%) in 2020. The reason for this decline has generated conflicting opinions in global literature. Although the number of emergency calls decreased during the pandemic period (from January to May 2020), the incidence of OHCAs either increased or remained unchanged in relation to activated emergency missions.

Consistent with other studies[10,11], OHCAs predominantly occurred at home, both in the pre-pandemic period (90%)[11] and during the 2020 pandemic (83.2%)[11], with a noticeable decrease in OHCAs in open areas (e.g. streets) due to the social changes caused by the virus. Additionally, the pandemic led to the emergence of the "Infective" pathology code (n=18, 4.1%), which was absent in 2020. The percentages of other codes remained relatively stable (Table 3).

The substantial number of OHCA cases occurring at home may be related to the fact that in Italy, the Emergency Dispatch Center often receives calls from relatives, even in cases of OHCA involving individuals with terminal illnesses or expected deaths. Most OHCA cases were coded as "four" (indicating a deceased patient) in both years, accounting for 92.3% in 2019 and 93.8% in 2020. These cases typically involved patients correctly identified as experiencing cardiac arrest who unfortunately did not survive despite resuscitation efforts. The percentage of patients who arrived alive at the emergency department was 7.8% in 2019 and 6.2%in 2020, falling within the international range of approximately 3-12%[10] for this rate. The significant variability in survival percentages worldwide can be attributed to differences in the interpretation of OHCA data and the incomplete standardisation of cardiac arrest descriptions, such as the Utstein style. The reduction in survival rates in both years may be attributed to the impact of the pandemic, as it worsened the health conditions of individuals, particularly those with chronic diseases, due to disruptions in primary care services[10,12].

Interview time, that is, the time spent by the dispatcher interviewing the caller, witnessed a slight increase in 2020 (from a mean of 94 ± 20 s in 2019 to 97 ± 29.8 s) due to the introduction of questions to assess COVID-19 symptoms and potential exposure. The literature suggests that OHCA recognition should be ensured within 90 s of receiving an emergency call[1,2]. However, for the delivery of pre-arrival instructions, a longer call duration is required compared with a standard interview. Therefore, the interview durations ranged from 68 s and 71 s for 2019 and 2020, respectively, confirming the trend of insufficient DA-CPR provision, which was proposed in only 21.5% (n=272) of cases. This percentage is below the level reported in the literature (30%)[3,10]. The increase in proposal rates in 2020 (n=112, 25.7%) compared to 2019 (n=160, 19.2%) might be attributed to the opening of the PSAPP (safety answering point) in December 2020 (n=6, 30%), which allowed for more time for dispatchers to propose and deliver DA-CPR, given the additional time gained through call filtering.

Pre-arrival instructions were not proposed for 672 cases (80.8%) in 2019 and 323 (74.3%) in 2020. The casuistry was analysed according to the Dami et al. 2018 model[9]. In the majority of OHCAs, in both 2019 (n=378, 56.3%) and 2020 (n=189, 58.5%), no specific justification for the absence of DA-CPR was provided. During call replay, no objective factors emerged to explain the lack of pre-arrival instructions. In these cases, the emergency nurse reassured the caller about the rapid arrival of the ambulance after

confirming the absence of consciousness and normal breathing.

DA-CPR was intentionally not proposed in 185 cases (27.5%) in 2019 and 76 (23.5%) in 2020, which is consistent with other international studies[6,12]. In our context, this situation could be explained by the high number of calls classified as OHCAs involving individuals in an obvious state of death in 2019 (n=44, 23.8%) and 2020 (n=22, 29%). Dami et al., 2018 study[9] identified the primary reason for intentionally not proposing DA-CPR as the presence of ongoing bystander-initiated CPR during the emergency call; in our study 24.3% (n=45) in 2019 and 25% (n=19) in 2020 versus 58% of cases. Pre-arrival instructions were not provided in 5% of the cases because of the inability to recognise and evaluate OHCA. The causes included a language barrier to the caller (n=8, 14.7% in 2019 and n=0, 0% in 2020) and inadequate breathing assessment (n=29, 85.3% in 2019 and n=11, 78.6% in 2020). These data underscore the need for improved dispatcher training programs that include call replays featuring patients exhibiting agonal breathing to enhance dispatch quality and to increase OHCA recognition and appropriate management. Training should also include exercises that focus on communication techniques to enable dispatchers to conduct clear, concise, and efficient telephone interviews. In some cases (n=25, 2.5%), the hesitation to propose DA-CPR was due to emotionally distressed callers, who were unable to answer direct questions about the victim's consciousness and breathing. In instances where pre-arrival instructions were proposed, callers declined to follow them in 9.6% (n=13) of the cases because they feared harming the victim. In such cases, dispatchers must have the necessary skills to guide the bystander in initiating initial resuscitation procedures to increase the likelihood of bystander-initiated CPR. Pre-arrival instructions also declined in patients with OHCA resulting from terminal illnesses (n=12, 8.8%). The difference between "awaited death" and "terminal patients" lies in the characteristics of the emergency call. In the former case, DA-CPR was not proposed because the caller immediately clarified that the victim was already seriously ill. In the latter, the dispatcher enquired whether the bystander wished to start resuscitation while awaiting the ambulance despite the patient being known to have a terminal illness.

This aspect raises questions regarding the purpose of CPR. It was introduced in 1965 to save individuals from certain deaths and was considered feasible when there was a reasonable chance of restoring a quality of life equivalent to that before the event. However, the majority of OHCA victims does not fully recover all brain functions, even with effective CPR. This occurs especially when resuscitation is started too late or is already applied to patients in a critical condition. The increase in cases involving terminal patients with cardiac arrest from 2019 (n=6, 7%) to 2020 (n=6, 11.8%) could be attributed to the pandemic, which exacerbated health conditions, particularly in individuals with chronic diseases. It also made it more challenging to access primary care services for death confirmation, prompting a reliance on emergency services.

Table 3. – OHCA alleged pathology codes of 2019 and 2020.

Alleged pathology code	2019 Year N = 832	2020 Year N = 435
C01 (Traumatic)	51 (6.1%)	14 (3.2%)
C02 (Cardiocirculatory)	490 (59%)	260 (59.8%)
C03 (Respiratory)	73 (8.8%)	29 (6.7%)
C04 (Neurologic)	163 (19.6%)	85 (19.5%)
C06 (Neoplastic)	9 (1.1%)	6 (1.4%)
C07 (Intoxication)	2 (0.2%)	2 (0.5%)
C09 (Gastroenterologic)	3 (0.4%)	2 (0.5%)
C15 (Infective)	0 (0.0%)	18 (4.1%)
C19 (Other pathology)	2 (0.2%)	0 (0.0%)
C20 (Unidentified pathology)	42 (5.1%)	23 (5.3%)

Limitations

The main limitation of our study was its retrospective nature. The lack of similar studies in the scientific literature did not provide comparable data.

We also had to exclude from the replay all calls with a duration of less than 60 seconds because the brief length of the call which can't be enough to purpose neither give pre-arrival instructions. In addition, all data comprehend cardiac arrests based on a numeric code susceptible to cardiac arrest, as all analyses are based on the return code from the rescue team. Finally, all data refer to cardiac arrests occurring in elderly people whose death, caused by cardiac arrest, was an awaited event.

Conclusions

These results serve as a starting point for potential reorganisation by implementing new dispatch-assisted procedures for OHCA patients. The adoption of a standardised protocol for delivering pre-arrival instructions, along with training programs focusing on OHCA and interview techniques, is strongly recommended based on the findings of our study. This was reinforced by the analysis of nighttime calls during which DA-CPR was not provided, including cases without clear justification. It is also recommended to modify the dispatch deliver program with the implementation of a flag to discern if cardiac arrest is suspected (YES/NOT) and if pre-arrival instructions are given to the bystander (YES/NOT).

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