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# Timing and Identification of the Cause and Treatment of a Cardiac Arrest: A Potential Survival Benefit

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**Highlights of the Study**

- During advanced cardiac life support, etiologic evaluation was performed in only 75% of the resuscitations.
- A presumptive etiology was found in only 46.8% of out-of-hospital cardiac arrests and 65.2% of in-hospital cardiac arrests.
- In 20% of the evaluations during cardiac arrest, mobile medical teams did not use the 4Hs and 4Ts system to search for an irreversible etiology.
- A significant association was found between the discovery of etiology and return of spontaneous circulation.
- Mobile medical teams do not start treatment on time according to the resuscitation guidelines, taking up to twice the recommended time in practice.

**Keywords**

In- and out-of-hospital cardiac arrest · Cause of cardiac arrest

**Abstract**

***Objective:*** The aim of this study was to evaluate how mobile medical teams (MMTs) search for the etiology of a cardiac arrest (CA) and to investigate the association between the discovery of etiology and patient outcome. ***Subjects and Methods:*** Resuscitations of all adult patients who experienced an in- or out-of-hospital CA between 2016 and 2018 were video recorded. All video recordings were reviewed. The time to start of "cause analysis" and time to treatment by the MMT were analyzed. Also, investigations performed during etiologic evaluation were examined: heteroanamnesis, medical history-taking, clinical examinations, technical investigations, and the use of the 4Hs and 4Ts method. ***Results:*** Of the 139 CA events included in this study, the MMTs performed etiologic evaluation in only 75% of the resuscitations, and in 20% of the evaluations, they did not use the recommended 4Hs and 4Ts method. Medical history-taking and heteroanamnesis were performed in the large majority, but often without clear cause. A presumptive etiology was found in 46.8% of out-of-hospital CAs and 65.2% of in-hospital CAs. A significant association was found between return of spontaneous circulation and the discovery of presumable etiology for out-of-hospital CAs ($p < 0.001$). The median time to treat-

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ment was 492 s (recommended: 130–250 s) for nonshockable rhythms and 422 s (recommended: 270–390 s) for shockable rhythms, up to twice the time advised according to the guidelines. ***Conclusion:*** The current approach for etiologic evaluation is not ideal. Further research is needed to establish a more structured and simplified approach.



## Introduction

The premise of advanced cardiac life support (ACLS) is to encourage return of spontaneous circulation (ROSC) when a patient has experienced a cardiac arrest (CA). Three priorities have been shown consistently to improve patient outcomes during ACLS. The first priority should always be to immediately give high-quality chest compressions with minimal interruptions [1]. Second, the team should focus on providing early defibrillation when indicated [2]. Once compressions are started, the third priority is to identify the cause of arrest and the subsequent treatment of reversible causes during cardiopulmonary resuscitation (CPR) [3, 4]. Identifying the underlying cause of the arrest is very time-sensitive as several reversible precipitants require rapid treatment. If left unchecked, a reversible cause can result in a prolonged interval between the time of arrest and ROSC. Also, avoiding a relapse in the minutes following ROSC depends on the treatment of the reversible cause. Failure to address the cause of the arrest will lead to a subsequent arrest which increases the risk of mortality [3]. Most reversible causes of arrest typically result in a nonshockable rhythm. For this reason, the 2018 updated ACLS algorithm recommends the initiation of treatment for reversible causes directly after the first two-minute cycle of chest compressions if the first rhythm after arrest is asystole or pulseless electrical activity (PEA) [5]. If the first rhythm is a shockable rhythm, treatment of reversible causes is advised after completing the second round of CPR and administering epinephrine [5]. In contrast to an arrhythmogenic CA, where the main treatment strategy consists of shock delivery, the current approach to PEA consists of unveiling and treating the underlying cause using anamnestic information and clinical signs [3, 6]. The most frequent reversible causes of CA with PEA as initial rhythm are commonly referred to by the mnemonic “4 Hs and 4Ts”: hypoxia, hypovolemia, hypo/hyperkalemia, hypo/hyperthermia, cardiac tamponade, tension pneumothorax, thrombosis, and toxins [3]. Treatment of the 4Hs and 4Ts is described extensively in the ACLS guidelines [3, 4].

The limited availability and knowledge of diagnostic equipment during prehospital care poses a challenge in the identification of the cause of arrest, as emergency physicians can often only rely on their own clinical examination and the collaboration of bystanders to ascertain what occurred during the event and to inquire about the patient’s medical history (heteroanamnesis) [7]. This means that during the challenging event of a CA, an abbreviated history and a clinical diagnosis need to be obtained, which is often difficult as typical signs and symptoms can be obscured by the arrest itself. To our knowledge, there are no robust data available on the actual performance of finding the cause during a CA. Therefore, the first aim of this study was to analyze how emergency physicians performed an etiologic evaluation. Second, adherence to the ACLS algorithm in the search for the cause of the arrest was evaluated. This study assessed how and when the mobile medical team (MMT) started the search for the cause of CA and when the team started treatment. Finally, this study investigated the influence of the discovery of presumable etiology on achieving ROSC.

## Methods

*Setting*

This observational prospective study was performed in a single tertiary referral university hospital in Leuven (UZ Leuven), Belgium. MMTs, consisting of an emergency physician and nurse, are deployed through the regional emergency dispatch center from the hospital to an out-of-hospital CA (OHCA) victim. This is additional to dispatching an ambulance with two emergency medical technicians or one technician and one nurse who start basic life support with an automated external defibrillator until the MMT arrives. When the MMT arrives prior to the ambulance, the resuscitation starts with only the MMT being present. Occasionally a trainee technician, nurse, or physician joins the resuscitation team. As such, out-of-hospital resuscitations are performed by teams of 4–6 healthcare workers. No ultrasound device or point-of-care testing was used out-of-hospital. In the event of an in-hospital CA (IHCA), the MMT is dispatched through an internal hospital procedure. All emergency physicians operating as part of an MMT have an ACLS certificate and regular experience in handling CA cases.

*Study Population*

All resuscitations performed by an MMT from UZ Leuven between July 1, 2016, and June 31, 2018, on adult patients (≥18 years) who experienced an IHCA or OHCA were eligible for inclusion. All etiologies, medical or traumatic, were included. Resuscitations were excluded if: (i) the CA was not fully video recorded, (ii) the quality of video recording did not allow for reliable data collection, or (iii) the patient was found with rigor mortis or other obvious signs of irreversible death.

**Table 1.** Resuscitation characteristics

| Variables | All | No | | All | No | |
|---|---|---|---|---|---|---|
| | OHCA (*n* = 109) | ROSC (*n* = 62) | ROSC (*n* = 47) | IHCA (*n* = 30) | ROSC (*n* = 11) | ROSC (*n* = 19) |
| Age, years | 72 (60.5–80) | 73 (64–80) | 70 (47–80) | 75 (64.5–82) | 73 (62–83) | 76 (65–82) |
| Gender (% male) | 66.1 | 67.7 | 63.8 | 66.7 | 63.6 | 68.4 |
| Witnessed arrest, % | 63.2 | 43.5 | 85.1 | 63.3 | 54.5 | 68.4 |
| Bystander CPR, % | 67.9 | 59.7 | 78.7 | 96.7 | 100.0 | 94.7 |
| Shockable rhythm, % | 14.7 | 8.1 | 21.2 | 10.0 | 0.0 | 15.8 |
| CCF (median %) | 90.6 (86.2–93.0) | 91.2 (87.5–93.2) | 90.3 (85.8–92.6) | 89.2 (85.2–91.7) | 90.8 (86.6–92.4) | 88.9 (85.2–91.0) |

Continuous variables are expressed as medians with their interquartile ranges. Categorical variables are expressed as frequencies with percentages.

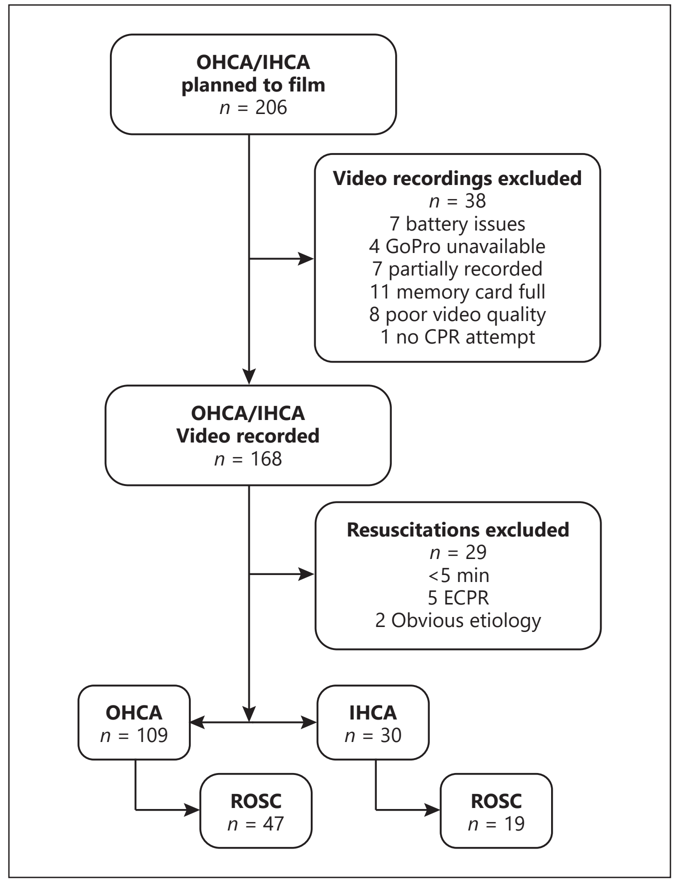


**Fig. 1.** Flow diagram of video-recorded CAs.

*Data Collection*

Each resuscitation was video recorded using a body-mounted GoPro camera (GoPro HERO 4), worn by the resuscitation team leader, and correctly oriented to the team leader's perspective to obtain a good overview of the entire CA setting. Upon arriving at the patient's side, the resuscitation leader would start the recording. The team leader was responsible for the video recording and the security of the videotape afterwards. Video recordings of all included resuscitations were reviewed by an ACLS-certified physician. The following demographic characteristics and CA event data were collected: age, gender, location of CA (IHCA or OHCA), witnessed arrest (yes/no), bystander CPR (yes/no), median arrival time of the emergency medical service, initially detected cardiac rhythm, time to start of cause analysis, time to treatment of the reversible cause, and patient outcome. The following actions were recorded as well: etiology questioning using the 4Hs and 4Ts, heteroanamnesis, medical history questioning, clinical examination, technical investigation, and resuscitation guidance by capnography. The definitions of the parameters are in line with the definitions suggested in the Utstein-style template [8]. Investigations were considered as performed as soon as they were touched, even if only very briefly or nonverbally (e.g., use of a stethoscope, clinical examination). The 4Hs and 4Ts were checked when all options were considered or when a definite conclusion was reached. For privacy reasons, video recordings were erased 2 weeks after the CA event. All study data were stored on a secure, hospital-based protected server.

*Data Analysis and Statistical Methods*

All data were imported into SPSS, version 26 (IBM, Armonk, NY, USA) for statistical analysis. Data were described as percentage and frequency of occurrence for categorical variables and as central tendency measures for continuous data. Mean and 95% confidence intervals were used for normally distributed data, and median and interquartile ranges were used for nonparametric continuous data. The association between etiology finding and ROSC was evaluated using a Fisher's exact test. A $p$ value <0.05 was considered statistically significant. Etiology was considered as found when the cause of the arrest was clearly pronounced by the emergency physician.

**Table 2.** Investigations* performed in the search for the etiology of the arrest

| | OHCA ($n$ = 79), $n$ (%) | IHCA ($n$ = 23), $n$ (%) |
|---|---|---|
| 4 Hs and 4 Ts | 63 (79.7) | 18 (78.3) |
| Heteroanamnesis | 62 (78.5) | 20 (87.0) |
| Medical history | 52 (65.8) | 20 (87.0) |
| Clinical examination | 8 (10.1) | 4 (17.4) |
| Technical investigation | 3 (3.8) | 4 (17.4) |

* Technical investigations included, but were not limited to, electrocardiograms, arterial blood gas analyses, and point-of-care ultrasound. Investigations were considered as performed as soon as patients were touched, even if only very briefly. The 4Hs and 4Ts were checked when all options were considered or when a definite conclusion was reached.

## Results

*Study Population*

Two hundred and six resuscitations of both IHCA and OHCA patients were video recorded between August 1, 2016, and August 1, 2018. A total of 38 video recordings were excluded for analysis due to poor video quality, memory card problems, battery issues, unavailability of the GoPro, and no CPR attempt due to obvious irreversible death (Fig. 1). As etiologic evaluation is not performed thoroughly during short-lived (<5 min) resuscitations and resuscitations including ECPR, these resuscitation attempts were excluded as well. Finally, 2 resuscitations were excluded as etiology was obvious without investigations upon arrival at the scene. As such, 139 CA events that required etiologic evaluation according to resuscitation guidelines were included for analysis.

A total of 109 video-recorded OHCA events were analyzed. The initially detected rhythm was asystole in 64 patients (58.7%), PEA in 25 patients (22.9%), and a shockable rhythm in 15 patients (13.7%). For 5 patients, the initial rhythm was determined using an automated external defibrillator that distinguishes only between a shockable (1–0.9%) and nonshockable (4–3.7%) rhythm. ROSC occurred in 47 patients (43.1%).

The initially detected rhythm in patients suffering from an IHCA was PEA in 16 patients (53.3%), asystole in 11 patients (36.7%), and a shockable rhythm in 3 patients (10.0%). ROSC was achieved for 19 patients (63.3%). Resuscitation characteristics are described in Table 1.

*Etiologic Evaluation*

In approximately one-fourth of the recorded resuscitations (OHCA: 27.5%, IHCA: 23.3%), MMTs did not perform an etiologic evaluation at any time. When etiology was searched, the median time from arrival at the patient's side to start of etiologic evaluation was 240 s (4 min) (IQR: 63–545 s) for OHCA and 255 s (4 min 15 s) (IQR: 97–459 s) for IHCA patients. Endotracheal tube $CO_2$ was used in 79 OHCAs (69.7%) and 16 IHCAs (53.3%). Table 2 provides an overview of the investigations performed in the search for the etiology of the arrest, irrespective of the result of the etiologic evaluation.

A presumptive etiology was found in 46.8% of OHCAs and 65.2% of IHCAs (Table 3). We examined the link between evaluation of etiology and outcome of resuscitation and found a significant association between ROSC and the discovery of presumptive etiology for OHCAs ($p$ < 0.001). For IHCAs, no statistical analysis was performed since cell count was too low.

*Adherence to Protocol*

For all resuscitations, we recorded the time to first rhythm, evaluation of etiology, shock, and other treatments (Table 4). The median time to treatment after finding the first rhythm was 492 s (8 min 12 s) (IQR: 144.25–732.75) for nonshockable rhythms and 422 s (7 min 2 s) (IQR: 30–996.5) for shockable rhythms, without the time to first shock as a possible and of course necessary treatment.

## Discussion

The aim of this study was to analyze how emergency physicians perform etiologic evaluations. The study also aimed to assess how and when the MMTs started the search

**Table 3.** Association between etiologic evaluation and ROSC

| | | OHCA, *n* (%) | | | IHCA, *n* (%) | | |
|---|---|---|---|---|---|---|---|
| | | etiology found | | | etiology found | | |
| | | no | yes | total | no | yes | total |
| ROSC | No | 32 (40.5) | 13 (16.5) | 45 (57.0) | 5 (21.7) | 6 (26.1) | 11 (52.2) |
| | Yes | 10 (12.7) | 24 (30.4) | 34 (43.0) | 3 (13.0) | 9 (39.1) | 12 (47.8) |
| | Total | 42 (53.2) | 37 (46.8) | 79 (100.0) | 8 (34.8) | 15 (65.2) | 23 (100.0) |

**Table 4.** Adherence to protocol

| Time to | OHCA | | IHCA | |
|---|---|---|---|---|
| | shockable | nonshockable | shockable | nonshockable |
| First rhythm(s) | 53.5 (32.25–66.25) (*n* = 14) | 68 (48–108.25) (*n* = 94) | 57 (54–150) (*n* = 3) | 60 (46–129) (*n* = 27) |
| Etiologic evaluation(s) | 240 (43–546.75) (*n* = 10) | 241.5 (63.75–564.5) (*n* = 68) | 162 (–) (*n* = 2) | 265 (116–475) (*n* = 21) |
| First shock(s) | 77 (50.5–210.25) (*n* = 14) | – | 119.5 (–) (*n* = 3) | – |
| Treatment other than shock(s) | 461 (42–1,486) (*n* = 3) | 571 (213.75–695.75) (*n* = 28) | 412.5 (–) (*n* = 2) | 579 (218.25–875) (*n* = 16) |

for the cause of CA and when the team started treatment. The most important task of MMTs during resuscitation consists of figuring out why the patient suffered a CA, in order to be able to offer the best possible treatment. For this reason, the ACLS protocol states that an OHCA should be managed by determining and treating the underlying cause of the arrest. This study confirms the importance of etiologic evaluation as we found a significant association between ROSC and the discovery of a presumptive etiology for OHCAs. These results are in line with the study of Bergum et al. [9, 10] where IHCAs were investigated using the limited data available from patient records and prearrest clinical symptoms. Bergum et al. [9, 10] also found a substantial survival benefit if etiologic evaluation was successful. Despite the recommendations of the guidelines, in approximately one-fourth of all video-recorded resuscitations where etiologic evaluation is expected to be done, this evaluation was not performed. We can, however, assume that in a fraction of these cases, the search to find any etiology was at least considered but not stated out loud. Unfortunately, why these evaluations were not performed remains unclear and should be studied.

Etiologic evaluation becomes especially important when patients have PEA as initial rhythm, which is the case in almost one-third of the CAs [11]. In most of these patients, the cause of the arrest is reversible if treated on time, making etiologic evaluation very time-sensitive and extremely urgent. This is traditionally done by going through the 4Hs and 4Ts. Especially in a prehospital setting, often characterized by a chaotic environment and limited availability of diagnostic equipment, this poses a challenge. In this setting, the first line of information comes from clinical examination of the patient and questioning bystanders about the circumstances of the event and the patient's medical history [7]. This information is then linked to the 4Hs and 4Ts [4]. During CPR, it is, however, difficult for the emergency physician to systematically recall this list. Jones et al. [12] demonstrated that among 37 emergency physicians observed, 27% failed to recall the most frequent causes of the 4Hs and 4Ts. In our study, approximately 20% of the emergency physicians did not use the 4Hs and 4Ts system. It is possible that in a fraction of these cases an etiology questioning may have been considered, but not out loud. Given that ACLS recommends that 4Hs and 4Ts are performed loudly to encourage team feedback, it seems there is a need to express a shared mental model. Therefore, it would be of interest for future research to use this video approach to debrief caregivers for quality and performance on a regular basis.

Comparison of the investigations performed and the respective results shows that in only 46.8% of OHCAs and 65.2% of IHCAs a presumptive etiology was found. More so, although medical history-taking and heteroanamnesis are performed in the large majority of CAs (Table 2), these inquiries are often without result. Heteroanamnesis was performed without result in 75.8% (47/62) of OHCAs, and no obvious medical history was found in 42.3% of OHCAs (Table 4). When an MMT works in a prehospital setting, it has no information on arrival and only very little information is collected as the resuscitation advances. Naturally, the success of these investigations thus depends on whether bystanders have witnessed the event and/or have a personal relationship with the patient. For IHCAs, the circumstances are very different. As chances are much higher that healthcare personnel are on-site and/or have easy access to the patient's medical record, nursing reports, and recent laboratory work, it is not surprising that these numbers are lower for IHCA patients (55% and 35%, respectively). Although MMTs should definitely perform these investigations, based on the results of the present study, expectations should be tempered.

For both IHCAs and OHCAs, the 2018 update of the AHA resuscitation guidelines recommends that treatment of the cause of the arrest be started after the second rhythm check for nonshockable rhythms or the third rhythm check for shockable rhythms. Translating this in time, the guidelines recommend treatment within 130–250 s (nonshockable) or 270–390 s (shockable) after discovery of the initial rhythm of the arrest. Subtraction of the time to first rhythm shows that in the majority of the video recorded resuscitations, MMTs do not succeed in starting treatment within the proposed time frame of the ACLS algorithm [5]. In our study, the median time to treatment was 492 s (IQR: 144.25–732.75) for nonshockable rhythms and 422 s (IQR: 30–996.5) for shockable rhythms. Especially for nonshockable rhythms, where one should start treatment as early as possible, it takes twice the advised time in practice.

Taken together, the results of this study indicate that the current approach for etiologic evaluation is not ideal. In 2014, the Carolinas Medical Center published a review article that tried to simplify the diagnostic approach to PEA called "A New Simplified and Structured Method in the Evaluation and Management of Pulseless Electrical Activity" [13]. Instead of the 4Hs and 4Ts system, this review proposes an ABCDE approach. Future research should focus on the development of a more structured etiologic evaluation where the 4 Hs and Ts could be combined with the ABCDE approach. As clinical and anamnestic information is often limited or absent, other instruments are required to help diagnose underlying causes. Despite the recommendations of the ACLS guidelines, many of these instruments are used currently in a limited way. A recent review emphasizes the importance of ultrasonography as it allows physicians to detect or exclude a variety of underlying causes [7]. Furthermore, although evidence concerning other diagnostic tools is limited, their use appears promising.

This observational study has several limitations. First, the study was performed in a single tertiary health care center and emergency medical service which limited the population. It is thus not possible to generalize these results for all emergency medical services. Second, although video recording is increasingly integrated into CA care protocols, direct observation might alter the behavior of team members and thus guideline adherence. Although performance bias should be considered, previous research by our research group has shown that no observer effect was present for this study population [14]. Third, in this study, staff on call formed ad hoc MMTs. Combined with the high turnover of residents in our ED, this added complexity might negatively influence teamwork as not all teams were familiar with the skills and knowledge of each team member prior to the intervention. Also, a large number of video recordings were excluded due to noninterpretable data. Furthermore, we were unable to assess compression quality, as both compression depth and rate were not monitored, but still, the chest compression fraction was calculated determining the proportion of time without compressions. Finally, lack of information on why exactly the team lead ultimately failed to determine the etiology is a limitation and worthy of further investigation. However, in this study, we did not ask the team any questions after the resuscitation so as not to compromise the observational aspect of the study.

## Conclusion

The results of this study indicate that etiologic evaluation is not consistently performed. Although a significant association was found between ROSC and the discovery of presumptive etiology, only in 75% of the resuscitations an etiologic evaluation was performed. However, even when an etiologic evaluation was performed, etiology was found in only 46.8% of OHCAs and 65.2% of IHCAs. Moreover, in 20% of the evaluations, emergency physicians did not use the 4Hs and 4Ts system. Medical history-taking and heteroanamnesis were performed in the large majority, but often without result. MMTs did not succeed in starting treatment on time as indicated by the resuscitation guidelines, taking up to twice the recommended time in practice. Further research is needed to examine whether etiologic evaluation can benefit from a more structured approach, including the widespread use of additional diagnostic tools.


## Acknowledgments

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## Statement of Ethics

This observational study was reviewed and approved by the UZ Leuven Institutional Ethical Review Board (approval and identification number S58657). The videotapes were viewed only by the team members taking part in a particular resuscitation and by the study investigators. All team members were informed of the recording before the start of the project and prior to the resuscitation; team members had the option not to participate in the study. Written informed consent was not required, as decided by the UZ Leuven Institutional Ethical Review Board.

## Conflict of Interest Statement

The authors have no conflicts of interest to declare.


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None.


## Author Contributions

Philippe Dewolf was involved in the concept and design of the study. The study dataset was extracted during video analysis by Philippe Dewolf. Philippe Dewolf and Lina Wauters extracted other data from the medical record database, conducted all data cleaning, and prepared the manuscript. Statistical analysis was performed by Jan Elen and Geraldine Clarebout. All other authors were involved in the revision of the article critically for important intellectual content and final approval of the version to be submitted. All have given approval to submit this article.

## Data Availability Statement

The data supporting the findings of this study are not publicly available since video recordings were erased within 2 weeks after the CA event for privacy reasons.

## References


1 Long B, April MD. Do mechanical chest compression devices compared with high-quality manual chest compressions improve neurologically intact survival of patients who experience cardiac arrest? Ann Emerg Med. 2019; 73(6):620–3.

2 Bækgaard JS, Viereck S, Møller TP, Ersbøll AK, Lippert F, Folke F. The effects of public access defibrillation on survival after out-of-hospital cardiac arrest: a systematic review of observational studies. Circulation. 2017; 136(10):954–65.

3 Panchal AR, Bartos JA, Cabañas JG, Donnino MW, Drennan IR, Hirsch KG, et al. Part 3: adult basic and advanced life support: 2020 American Heart Association Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2020; 142(16 Suppl 2):S366–468.

4 Lott C, Truhlář A, Alfonzo A, Barelli A, González-Salvado V, Hinkelbein J, et al. European resuscitation council guidelines 2021: cardiac arrest in special circumstances. Resuscitation. 2021;161:152–219.

5 Panchal AR, Berg KM, Kudenchuk PJ, Del Rios M, Hirsch KG, Link MS, et al. 2018 American Heart Association focused update on advanced cardiovascular life support use of antiarrhythmic drugs during and immediately after cardiac arrest: an update to the American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2018;138: e740–9.

6 Volpicelli G. Usefulness of emergency ultrasound in nontraumatic cardiac arrest. Am J Emerg Med. 2011;29(2):216–23.

7 Van den Bempt S, Wauters L, Dewolf P. Pulseless electrical activity: detection of underlying causes in a prehospital setting. Med Princ Pract. 2021;30(3):212–22.

8 Perkins GD, Jacobs IG, Nadkarni VM, Berg RA, Bhanji F, Biarent D, 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. Circulation. 2015;132:1286–300.

9 Bergum D, Haugen BO, Nordseth T, Mjølstad OC, Skogvoll E. Recognizing the causes of in-hospital cardiac arrest: a survival benefit. Resuscitation. 2015;97:91–6.
10 Bergum D, Nordseth T, Mjølstad OC, Skogvoll E, Haugen BO. Causes of in-hospital cardiac arrest: incidences and rate of recognition. Resuscitation. 2015;87:63–8.
11 Soar J, Böttiger BW, Carli P, Couper K, Deakin CD, Djärv T, et al. European resuscitation council guidelines 2021: adult advanced life support. Resuscitation. 2021;161:115–51.
12 Jones N, Lammas C, Gwinutt C. Poor recall of "4Hs and 4Ts" by medical staff. Resuscitation. 2010;81(11):P1600.http://dx.doi.org/10.1016/j.resuscitation.2010.06.015.
13 Calder LA, Mastoras G, Rahimpour M, Sohmer B, Weitzman B, Cwinn AA, et al. Team communication patterns in emergency resuscitation: a mixed methods qualitative analysis. Int J Emerg Med. 2017;10:24.
14 Dewolf P, Rutten B, Wauters L, Van den Bempt S, Uten T, Van Kerkhoven J, et al. Impact of video-recording on patient outcome and data collection in out-of-hospital cardiac arrests. Resuscitation. 2021;165:1–7.