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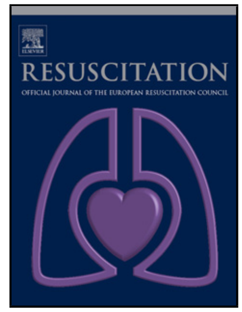

Improving Emergency Call Detection of Out-of-Hospital Cardiac Arrests in the Greater Paris Area: Efficiency of a Global System with a New Method of Detection

Clément Derkenne, Daniel Jost, Oscar Thabouillot, Frédérique Briche, Stéphane Travers, Benoit Frattini, Xavier Lesaffre, Romain Kedzierewicz, Florian Roquet, Félicité de Charry, Bertrand Prunet, Paris Fire Brigade Cardiac Arrest Task Force

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TITLE

Improving Emergency Call Detection of Out-of-Hospital Cardiac Arrests in the Greater Paris Area: Efficiency of a Global System with a New Method of Detection

AUTHORS

Clément DERKENNE, MD,
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris
Corresponding Author, Equal First Author
+33 627 513 401
clement.derkenne@pompiersparis.fr and clement.derkenne@gmail.com

Daniel JOST, MD,
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris
&
Sudden Death Expertise Center, Hôpital Pompidou,
1, Rue Leblanc, 75015 Paris
Equal First Author

Oscar THABOUILLOT, MD
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris

Frédérique BRICHE, MD
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris

Stéphane TRAVERS, MD,
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris
&

French Military Health Service, Val de Grâce Military Academy,
1, Place Alphonse Laveran, 75005 Paris

Benoit FRATTINI, MD,
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris

Xavier LESAFFRE, MD
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris

Romain KEDZIEREWICZ, MD,
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris

Florian ROQUET, MD,
Critical Care Department, Hôpital Pompidou,
1, Rue Leblanc, 75015 Paris
&
INSERM 1153 Unit,
Hôpital St Louis
1, Avenue Claude Vellefaux, 75010 Paris

Félicité de Charry, MD,
Percy Military Teaching Hospital
1 rue Raoul Batany, 92140 Clamart

Paris Fire Brigade Cardiac Arrest Task Force,
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris

Bertrand PRUNET, MD, PhD,
Emergency Medical Department, Paris Fire Brigade

1, Place Jules Renard, 75017 Paris
&
French Military Health Service, Val de Grâce Military Academy,
1, Place Alphonse Laveran, 75005 Paris

PARIS FIRE BRIGADE CARDIAC ARREST TASK FORCE:
Daniel JOST, MD; Frederic LEMOINE, Nurse; Vincent LANOE, Nurse; Benoit FRATTINI, MD; Eric GAUYAT; Sabine LEMOINE, MD; Frederic BRICHE, MD; Xavier LESAFFRE, MD; Laure ALHANATI, MD; Jean-Paul FREIERMUTH, MD; Romain KEDZIEREWICZ MD; Ludovic DELHAYE, Nurse; Olga MAURIN, MD; Clément DERKENNE MD; Laurent PRIEUX, MD; Olivier YAVARI, MD; Vivien HONG, MD; Olivier STIBBE, MD; Stéphane TRAVERS, MD; and Bertrand PRUNET, MD, PhD;
Emergency Medical Department, Paris Fire Brigade
1, Place Jules Renard, 75017 Paris

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ABSTRACT

Aim

The detection of cardiac arrests by dispatchers allows telephone-assisted cardiopulmonary resuscitation (t-CPR) and improves Out-of-Hospital Cardiac Arrest (OHCA) survival. To enhance the OHCA detection rate, in 2012, the Paris Fire Brigade dispatch center created an original technique called "Hand On Belly" (HoB). The new algorithm that resulted has become a central point in a broader program for dispatch-assisted cardiac arrests.

Methods

This is a repeated cross-sectional study with retrospective data of four 15-day call samples recorded from 2012 to 2018. We included all calls from OHCAs cared for by Basic Life Support (BLS) teams and excluded calls where the dispatcher wasn't in contact directly with a witness. The primary endpoint was the successful detection of an OHCA by the dispatcher; the secondary endpoints were successful t-CPR and measurements of the different time intervals related to the call. Logistic regressions were performed to assess parameters associated with detecting OHCAs and initiating t-CPR.

Results

From 2012 to 2018, among the detectable OCHAs, the proportion correctly identified increased from 54% to 93% ; the rate of t-CPRs from 51% to 84%. OHCA detection and t-CPR initiation were both associated with HoB breathing assessments (adjustedOR:89, 95%CI:31-299, and adjustedOR:11.2, 95%CI:1.4-149, respectively). Over the study period, the times to answering calls and the time to sending BLS teams were shorter than those recommended by international guidelines; however, the times to OHCA recognition and starting t-CPR delivery were longer.

Conclusions

The HoB effectively facilitated OHCA detection in our system, which has achieved very high performance levels.

Key Words: Cardiac arrest, Telephone Cardio-Pulmonary Resuscitation, Dispatch-Assisted Cardiopulmonary Resuscitation

Introduction

During an out-of-hospital cardiac arrest (OHCA), each link in the survival chain has an impact on the patient's outcome and allow one to continue to the next link until survival is achieved. The first link, "early recognition of OHCA", is probably the most crucial.[1] In France, the incidence of OHCAs is about 50/100,000 inhabitants/year. Although 30-40% of the population has received at least one training session in first aid, less than 10% of bystanders recognize OHCAs prior to the call for help.[2–5]

In the literature, dispatcher-assisted cardio-pulmonary resuscitation (DA-CPR) combines cardiac arrest (CA) detection and telephone-assisted cardio-pulmonary resuscitation (t-CPR). It increases the OHCA detection rate and the likeliness that chest compressions (CC) will be performed by bystanders until the arrival of the basic life support team (BLS). Indeed, bystander, whatever his level of first aid knowledge, can limit the time spent without no-flow and reduce OHCA mortality.[5–10] This progress was associated with the successful implementation of various actions by the DA-CPR program, including: revised protocols, training, and quality improvement.[11]

Training and quality assessments of all emergency calls have been strengthened in the Paris Fire Brigade call center since 2011. In addition, the method for evaluating the respiratory status of an unconscious patient has been modified. The American Heart Association (AHA) recommends that the dispatcher asks the caller: "Does the victim breathe normally?". The effectiveness of this question is associated with a low level of evidence. In the literature, we did not find any other method for detecting CA.[12,13] With the "hand on belly" (HoB) method, the Paris Fire Fighters Dispatch Center invented an objective, simple, reproducible tool for assessing respiratory status in a relevant way. In this technique, the dispatcher asks the caller to places his/her hand on the victim's belly. Each time the belly rises, the caller says "TOP" on the phone. The time interval between two "TOPs" is taken to estimate the ventilation frequency. Based on the threshold value chosen, the caller is told to start CCs. The HoB was implemented in 2011 and was first evaluated by Travers et al and showed positive results.[4] The purpose of this study was to assess performance improvement in a DA-CPR program over the period of 2012 to 2018. Additionally, we compared features of the DA-CPR program to those of the 2016 AHA guidelines, including OHCA detection, the t-CPR rate, and time interval compliance.

Methods

Dispatch center organization

The Paris Fire Brigade dispatch center is the largest Public Safety Answering Point (PSAP)/Emergency Medical Dispatch (EMD) in France and one of the most important in Europe. It is responsible for an area of 800 km^2 with 7 million inhabitants; it dispatches 1400 Basic Life Support (BLS) teams and 75 Emergency Medical Support teams per day (14). Since 2016, emergency calls have been routed through a common answering platform for firefighters and police officers, with a two-step call management system; this replaced the previous one-step system. First, the PSAP operator screens 14,500 calls/day and allows 3,100 specific requests for assistance to pass to the EMD dispatcher. Then, call taking, CA screening, and t-CPR are performed by trained firefighters. Calls are managed by, first, detecting unconscious victims. Then, after "rapid activation" of a BLS team, the HoB algorithm is performed to detect a potential CA; next, the dispatcher starts t-CPR according to a specific instruction list (supplemental material)

Evolution of the DA-CPR program

In 2012, inspired by the AHA guidelines, a DA-CPR quality program was set up to introduce tutoring for the youngest operators by their more expert elders.[13] The tutors encouraged over-triage and a more systematic use of the HoB. When a CA was not detected, the tutor and operator listened again to the corresponding telephone call, to ensure positive assimilation. When dispatchers successfully detected a complex CA, a reward was given in the same way that any firefighter was rewarded after an outstanding intervention. Regular performance measurements were carried out, and the results were communicated to dispatchers to reinforce motivation.

<u>Study design and population</u>

A repeated cross-sectional design was planned for this study. We studied tapes of recorded telephone calls from four periods: 2012 (15-31 November), 2015 (26 January to 09 February), 2017 (1-15 October), and 2018 (1-30 November). In our servers, tape search is manual, particularly long and complex. The analysis periods were therefore chosen according to the availability of the technical teams, to the absolute exclusion of any other consideration. The 2018 period was chosen longer than the other periods because we wanted more precision in the measurement of delays and in the exhaustiveness of the reasons of wasting time (second endpoints). It has not been possible to increase the size of older periods (tape storage unavailable).

From the Sudden Cardiac Deaths in Greater Paris registry, we have included all OHCAs cared for by a BLS team during those periods. Two emergency physicians (C.D and O.T.) retrospectively listened to eligible telephone calls, and in case of disagreement, two others physicians evaluated the call (D.J and F.B.). We excluded calls, when the caller had detected the CA, when the caller was not located in close proximity to the patient, when the archived tape was corrupted, or when the call was a third-party call, according to the AHA definition of recognizable calls.[15]

Data collection

In addition to the Utstein variables, we collected data on the CA detection status, t-CPR delivery, and the breathing assessment. The CA was validated when the dispatcher pronounced the words "Cardiac Arrest" or "Chest Compressions". T-CPR delivery was considered successful, when, in the recording, the caller said they were doing chest compressions. The breathing assessment was classified as follows: assessment not realized; assessment realized without HoB; or assessment realized with HoB. Time intervals were derived from the call tapes.[16]

The main endpoint was the OHCA detection rate and its trend over the six-year study. Secondary endpoints were the rates and evolution of OHCAs detected by the operator; whether detection was followed by t-CPR; whether a defibrillator was requested; and the different time intervals derived from the call. Finally, we analyzed the 2018 cohort to identify possible factors associated with the times required to detect OHCAs and start t-CPR.

Statistics

Categorical variables are expressed as the frequency and proportion, with 95% confidence intervals. Qualitative variables are expressed as the mean and standard deviation or the median and interquartile range. Comparisons of variables among the four periods were performed with the Fisher exact test or analysis of variance (ANOVA), as appropriate. After describing the main patient characteristics, two logistic regression models were created to assess the variables associated with OHCA detection and with initiating t-CPR. The variables were selected for the model, based on (*i*) their clinical relevance and previous knowledge from the literature (location, age, sex, traumatic) (*ii*) a minimization with the Akaike information criterion, and (*iii*) always retaining the period in the model. When applicable, the inclusion of clinically relevant variables took precedence. Potentially relevant interactions were assessed for inclusion in the model.

The 2018 cohort subgroup analysis aimed to determine the frequency and the reasons for wasting time at different points during the telephone conversation about an OHCA. We classified each event/practice according to its potential for improvement, as follows: imperative, possible, difficult, or impossible. Similarly, we categorized the time wasted according to the person or event responsible, in this case: the caller, the dispatcher, the logistics or the technology. The event frequency did not predict the amount of time lost. All analyses were performed with R software, version 3.3.3 for Windows. The significance level was 5%.

Regulatory and ethical considerations

The data collection and processing were carried out in strict compliance with French regulations (CNIL MR003). The study was approved by the Ethics Committee of the French Anesthesia Society (IRB 00010254 - 2018 - 003).

Results

Over the 6 years of the study period, the number of calls increased by 5% per year, i.e. 870,000 more calls were taken in 2018 than in 2015, with the same number of dispatchers.

OHCA detection and t-CPR rate

Of 790 patients that experienced OHCAs, 321 were potentially recognizable by the dispatcher and were included in the analysis. Flowchart is available on Figure 1. Patient, caller, and dispatcher characteristics are shown in Table 1. We also analyzed features of dispatcher work and basic and advanced life support. Among all patients that experienced OHCAs, 64 (8.1%) had received bystander-CPR before the call or a CA was detected before the call (Figure 1).

In 2012, dispatchers assessed breathing for 71% of patients, and this proportion increased to 97% in 2018 (Figure 2). Dispatchers correctly identified 54% of recognizable OHCAs in 2012, 76% in 2015, 83% in 2017, and 93% in 2018. The AHA performance goal was 95% Among the identified OHCAs, t-CPR performance increased from 51% to 84% during the 6 years of observations. The AHA t-CPR performance goal was 75%. During the study period, the rate of dispatchers searching for a defibrillator increased from 0 to 20% and the rate of ongoing CC at BLS arrival increased from 36% to 83% (p=0.01). In contrast, the rate of CPR-bystander before call did not improve significantly (4% to 17%, p=0.22), nor did the survival rate. Callers reported breathing movements in the recordings for 76 (24%) patients. Among the 21 patients discharged alive from hospital, 11 were CPC 1 and 6 were CPC 2 (4 data missing).

After adjusting for confounders, OHCA detection was associated with breathing assessments, particularly when assessed with HoB (aOR: 13.1 95%CI: 4.8-39.5), during the 2018 period (aOR: 3.4, 95%CI: 1.1-10.8), and when the OHCA occurred in a public place (aOR: 0.14, 95%CI: 0.05-0.4) (Table 2), compared to an OHCA at home. When only the detected OHCAs were considered, the t-CPR was associated with younger patients and with the HoB breathing assessment. Neither the age nor the seniority of dispatchers was associated with the success of OHCA detection or t-CPR. The sensitivity of HoB for CA detection was measured among patients at 96.2%.

<u>Delay measurements</u>

In 2015, callers could directly call the EMD within 25 s (95%CI: 15-35). In 2018, callers first contacted the PSAP within 14 s (95%CI: 12-20), then the EMD within 48 s (95%CI: 40-68). The AHA minimum acceptable standard was 60 s (Figure 3). No call was ended before processing by a dispatcher, and the longest times to picking up the call were 68, 36, and 24 s, in 2015, 2017, and 2018, respectively.

The median time interval between a "1-1-2 call" and sending a BLS remained broadly unchanged between 2012 and 2018. The time interval to OHCA recognition increased by about 40 s between 2012 and 2018, from 168 s (95%CI: 128-206) to 210 s (95%CI: 164-285). Moreover, the time interval between the "1-1-2 call" and the beginning of t-CPR increased by 109 s during the same time period (from 230 s, 95%CI: 208-330 to 339 s, 95%CI: 256-454). For the two latter time intervals, the AHA minimum acceptable standard was 150 s, which was exceeded most of the time.

2018 cohort analysis

The 2018 cohort included 122 calls. Time was wasted during 59% of the calls at the PSAP and during 95% of the calls at the EMD (Table 3). There were 36 reasons for wasting time, and of these, 16 seemed impossible to change, 8 seemed difficult to correct, 5 seemed possible to correct, and 7 were subject to mandatory prompt correction.

Discussion

Main results and DA-CPR program results

The main finding of this study was that the OHCA detection rate significantly and constantly increased, from 2012 (54%) to 2018 (93%). At the same time, the percentage of recognized OHCAs that received t-CPR increased from 51% to 83%. From 2017, our results almost achieved the goals recommended by the AHA; i.e., rates of 95% and 75%, respectively (14). Our rates were close to the highest reported in the literature[17–19], and they were associated with a significant increase in the rate of patients that received ongoing CC at BLS arrival; indeed, our rates exceeded the French and Swedish national average rates (53% and 68.2%, respectively).[20,21] We demonstrated that the application of a DA-CPR program, with its three components - algorithm, operator training, and performance measurements - could effectively improve the rates of OHCA detection and ongoing CPR at BLS arrival. On the other hand, there was no increase in the shockable rhythm rate or in patient survival, as might have been expected. This lack of downstream effects could be related to excessively long delays before starting the CCs, stagnation in CC quality, and/or difficulty in monitoring the depth of compressions remotely.[22–25] Despite the absence of AHA guidelines for locating a defibrillator, the rate of searching for a defibrillator increased until 2017, and then it remained constant. The search for defibrillators was then assigned to chief dispatchers, who were trained in using the “Staying Alive” mobile-responder application and defibrillator mapping.[26]

Hand on Belly algorithm

The main factors associated with successful OHCA detection were the occurrence of a CA outside a public place and the operator recognizing the ventilation status, particularly when the status was ascertained with the HoB. In 2012, the Paris Fire Brigade dispatch center was using the AHA question "is the patient breathing normally?", without systematically using the HoB technique.[2,13] The problem with this question was that the definition of "normal" was subjective. Similarly, the answer to this question was based on complex linguistic characteristics that could mislead the dispatcher, particularly when the patient displayed agonal breathing.[27] Currently, the AHA question is commonly used to draw the caller's attention to the ventilation status; then, the question is quickly followed by the HoB method, which has become the reference in our system. The HoB method quantifies the respiratory rate; it is based on the fact that the termination of gasps begins from the abdomen. The use of HoB was associated with a higher t-CPR rate, because it required the rescuer to adopt a physical position quite similar to that of a CC provider.[28]

Public places were adversely associated with the detection of OHCAs. In fact, a high incidence of gasping and a large number of bystanders at the time of the collapse are well-known risk factors for non-detection, and they present a major challenge to dispatchers.[2,4,6,29,30]

Dispatcher training

Initial training

All the dispatchers included in the study had at least 3 years of BLS experience; this was an important prerequisite for comprehending clinical situations over the telephone.[29] In addition to their seniority, which was not associated with CA detection, their initial training program was crucial to improving detection. The initial dispatcher training consisted of approximately 150 h of training, including about 10 h specifically focused on OHCA detection and CC guidance.

Continuous training

The rate of calls to the PSAP and to the EMD increased significantly during the study period, but the number of dispatchers remained constant, at 140. These dispatchers handled about 48,000 calls over each 15-day period, and they had the opportunity of detecting about 70 CAs, which comprised about 0.15% of all calls. Therefore, OHCAs were rather rare events for each operator. However, the HoB was performed for all unconscious patients, which were more numerous than patients with CAs. The number of CAs processed by an operator was associated, based on the literature, with more frequent CA detection by that operator; continuous training was also crucial in maintaining a high level of detection.[6,31,32] In our experience, motivation was reinforced by dispatcher awards and postings on social networks of encounters with survivors. In addition, the heads of the call centers, doctors, and dispatchers contributed to animating the dynamics around CAs at the dispatching center. For example, some innovative projects included implementing “Staying Alive” mobile dispatch application, for lay responders, and the Corti® artificial intelligence application, for dispatchers.[26,33,34] The HoB method was used by dispatchers that were basic firefighters trained in CA detection. Accordingly, we believe that the HoB method could potentially be deployed in other dispatch centers.

Improved time intervals

The time intervals from the 1-1-2 call to the PSAP, to the EMD, to acquiring the address, and to sending the BLS team were most often within the limits recommended by the AHA. In 2016, the transition from a one- to two-level call center was necessary, due to the addition of police dispatches to the Paris Fire Brigade dispatch center. This new organization and the ever-increasing number of calls have been associated with an increase in the time to contact the EMD, but not in the time required to send a BLS team (105 s in 2012 vs. 106 s in 2018). The time added by this two-level system was an investment in the successful detection of CAs in more critical patients. With this system, the order of answering calls moved from chronological priority to medical priority. Conversely, the time interval between OHCA screening and the start of t-CPR increased over the years. Screening for more complex OHCAs and OHCAs that occurred at the end of the call increased the rate of OHCA detection, but the time intervals also increased.[35] Repeating the HoB more than twice could also increase delays.

To overcome the delays and reduce no-flow, all actions are legitimate when they limit the time to sending the BLS and starting t-CPR. In the 2018 cohort, there were 15 caller-related reasons for time wasted. Resolving these issues might be expensive and time-consuming; it may require a program for training the population in life-saving actions. However, this approach could reduce the time to applying a defibrillator. To resolve dispatcher-related delays, it may be possible to provide continuous training in communication techniques, like reformulating instructions, requesting feedback, practicing slower speaking rates, improving diction, adapting the language, using transition sentences...etc. In addition, dispatchers should be reminded to respect the protocol (i.e., no more than two HoBs; complete one task before starting another). Moreover, the checklist for t-CPR has improved from 7+6 steps in 2012 to 5+8, in 2019 (supplemental material).[36,37]

In the present study, all calls were authenticated cardiac arrest calls : we did not measure the false positive rate for HoBs, because of the technical and logistical impossibility of manual screening among our 14,500 daily calls (1,087,000 calls over the 75 study days). In any case, we assumed over-triage conditions, which appeared to have little negative effect on patients with a beating heart.[38] One technology-related reason for time wasting was that the PSAP and EMD used different call-taking software, which required the caller to repeat the information. One third of callers spontaneously gave their address to the PSAP, when it was not useful. Neither level had a smartphone/ landline phone geolocation system, like the *Advanced Mobile Location* application. A new national software interface, with more reactive mapping, is planned for implementation in 2021.[39] Computer-assisted screening is also a very promising method for the future.[33] This method aims to offer quality screening that is independent from fatigue, reduced concentration, or inappropriate questions from the dispatcher.

Limitations

Among the 10 OHCAs/day that occurred, only half was recognizable, according to the definition of the AHA. This rate was well below the 80% previously reported by Lewis et al.[2,15] This rate might be explained by calls from a third party, due to the several emergency numbers available in France.

An optimal OHCA dispatch method should achieve a high detection rate, a high t-CPR rate, and a rapid execution rate. Our study confirmed the effectiveness of the HoB method; this system achieved a CA detection rate and t-CPR rate close to the highest levels required by the AHA. However, there is a potential cost in time before CPR initiation, based on the accuracy of recognition and communication between the phone and caller. The optimal HoB method (i.e., not repeated more than twice) might be equivalent or more effective than the alternative method of: *NO (consciousness), NO (breathing), and GO (chest compressions).*[40]

We do not believe that a different number of patients between each study period could bias the size of the effect, i.e. in our case the sensitivity of the screening process even if it affects variance. However, we observe a difference between the periods / strategies, meaning that there is a sufficient number of patients for each period for us to detect it. Although we did not identify any other confounders that might have affected the results during the study period, we could not rule out the possibility that other confounding factors might have existed.

Conclusion

The HoB effectively facilitated OHCA detection in our system, which has achieved very high performance levels.

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CONFLICTS OF INTEREST

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AFFILIATIONS

From Paris Fire Brigade, Paris, France (CD, DJ, OT, FB, ST, BF, XL, RK, PFBCATF, BP); from Percy Military Teaching Hospital, Clamart, France (FdC); from Pompidou Hospital, Paris, France (FR)

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LEGEND TO FIGURE AND TABLE

Table 1: Patients characteristics and outcome.

data are in number (%) or in median [25^{th}-75^{th}]

**included recognizable OHCA, archive corrupted, caller not on scene, cardiac arrest already detected by caller and CPR ongoing before the call, but not 3rd party call (no specific details for measures are available on AHA recommendations).*

HoB: Hand of Belly method for OHCA detection ; CPR: CardioPulmonary Resuscitation ; EMD Emergency Medical Dispatch

Table 2: Multivariate analysis for Out-of-Hospital Cardiac Arrest (OHCA) detection and telephone CardioPulmonary (t-CPR) on complete cases.

OR: Odd-Ratio; 95%CI: 95% Confident Interval, HoB: Hand of Belly method for OHCA detection

Table 3. Frequency and reasons for wasting time at different times during the telephone conversation for cardiac arrest within the 2018 cohort

Figure 1: Flowchart

Figure 2 : Out-of-Hospital Cardiac Arrest (OHCA) detection and telephone CardioPulmonary (t-CPR) rate

Figure 3: Time interval for six steps of Dispatch-Assisted cardio-pulmonary resuscitation (seconds)

PSAP: Public Safety Answer Point; EMD: Emergency Medical Dispatch; OHCA : Out-of-Hospital Cardiac Arrest; BLS: Basic Life Support Team; t-CPR : telephone CardioPulmonary Resuscitation; AHA: American Heart Association

Supplemental material : Additional Figure 1: Hand on Belly algorithm

Supplemental material : Additional Table 1: 2012 7+6 instructions list to guide telephone-Cardio-Pulmonary Resuscitation and 2019 5+8 instructions list to guide telephone-Cardio-Pulmonary Resuscitation

Supplemental material : Additional Table 2 Patients characteristics and outcome with missing data

Table 1.

		Period 2012 n=69	Period 2015 n=82	Period 2017 n=48	Period 2018 n=122	P value
PATIENT CHARACTERISTICS						
Male		45 (65)	49 (60)	30 (63)	71 (57)	0.74
Age, years		65 [51-79]	71 [58-84]	66 [55-81]	70 [55-81]	0.72
Out-of-Hospital Cardiac Arrest (OHCA) CHARACTERISTICS						
Location	home	45 (65)	65 (79)	41 (85)	99 (81)	0.31
	public /work place	18 (26)	17 (21)	7 (15)	23 (18)	
Traumatic cardiac arrest		4 (6)	6 (7)	2 (4)	7 (6)	0.95
Seizure at the call		2 (3)	3 (4)	3 (6)	6 (5)	0.86
CALLER CHARACTERISTICS						
Caller-patient link	None	3 (4)	18 (22)	7 (15)	35 (29)	0.24
	Close relative /family	31 (45)	61 (74)	31 (63)	87 (71)	
Ability to perform CPR	None	26 (38)	61 (74)	34 (71)	101 (83)	0.22
	First-aid /healthcare worker	3 (4)	18 (22)	4 (8)	21 (17)	
DISPATCHER WORK						
Breathing assessment	Not realized	20 (29)	14 (17)	7 (15)	4 (3)	<0.001
	Yes without HoB	23 (33)	17 (21)	1 (2)	20 (16)	
	Yes with HoB	21 (30)	51 (62)	41 (83)	99 (80)	
Number of Hand on Belly (HoB) tests *(on breathing assessment with Hob)*	1		25 (49)	22 (54)	46 (46)	0.64
	2	*N/A*	16 (31)	11 (27)	44 (44)	
	>2		10 (20)	8 (19)	9 (9)	
Breathing movements reported by caller or audible on the tape (%)		14 (20)	15 (18)	13 (27)	34 (28)	0.48
Recognizable OHCA correctly identified		37 (54)	62 (76)	40 (83)	113 (93)	<0.001
Correctly identified OHCA receiving t-CPR		19 (51)	52 (84)	33 (83)	95 (84)	<0.01
Total OHCA* cases correctly identified		50 (53)	78 (66)	52 (70)	142 (72)	0.01
Correctly identified OHCA with dispatcher asking for a defibrillator (%)		0	6 (10)	8 (20)	23 (20)	0.01
BASIC and ADVANCED LIFE SUPPORT						
CC ongoing at BLS arrival		25 (36)	51 (62)	35 (73)	101 (83)	0.01
Shock delivered by AED ≥1		15 (22)	15 (18.3)	14 (28)	32 (26)	<0.01
Survival until hospital admission		19 (28)	21 (26)	17 (35)	32 (26)	0.63
Discharge alive from hospital		5 (7)	3 (4)	4 (8)	9 (7)	0.12
DISPATCHER CHARACTERISTICS						
Dipatcher age, years		30 [28-33]	32 [30- 34]	33 [30-37]	30 [28-34]	0.05
Seniority at the EMD, years		4.0 [3.5-4]	1.4 [0.3-3.2]	3.0 [3-3]	2.7 [1.4-3.8]	<0.001

Table 1 patients characteristics and outcome

data are in number (%) or in median [25th-75th]

**included recognizable OHCA, archive corrupted, caller not on scene, cardiac arrest already detected by caller and CPR ongoing before the call, but not 3rd party call (no specific details for measures are available on AHA recommendations).*

HoB: Hand of Belly method for OHCA detection ; CC: Chest Compressions ; EMD Emergency Medical Dispatch

Table 2

	Multivariate analysis for OHCA detection		Multivariate analysis for t-CPR on recognized OHCA	
	OR [95% CI]	p	OR [95% CI]	p
2012 period	1		1	
2015 period	1.6 [0.6 - 4.5]	0.38	4.9 [1.9-17.0]	0.002
2017 period	1.2 [0.3 - 5.1]	0.76	5.0 [1.5-18.5]	0.01
2018 period	3.4 [1.1 - 10.8]	0.03	5.2 [2.0-13.6]	<0.001
OHCA at home	1		1	
OHCA on street / workplace	0.14 [0.05 - 0.4]	<0.001	2.1 [0.6-9.5]	0.28
Breathing assessment without HoB	1		1	
No breathing assessment	0.14 [0.05-0.4]	0.001	0.25 [0.02-2.20]	0.24
Breathing assessment with HoB	13.1 [4.8 – 39.5]	<0.001	2.9 [1.2-7.0]	0.02
Patient age, per 10 years older	0.95 [0.8-1.2]	0.65	0.01 [0.01-0.01]	<0.001
Gender (male : ref)	1.22 [0.5-3.0]	0.66	0.6 [0.3-1.3]	0.19
Dispatcher age, per 5 years older			0.72 [0.5-1.1]	0.12
Medical cardiac arrest (trauma : ref)			0.23 [0.05-1.06]	0.05

Table 2: multivariate analysis for OHCA detection and t-CPR on complete cases (respectively n=312 and n=239 observations)

OHCA: Out of Hospital Cardiac Arrest; OR: Odd-Ratio; 95%CI: 95% Confident Interval, HoB: Hand of Belly method for OHCA detection

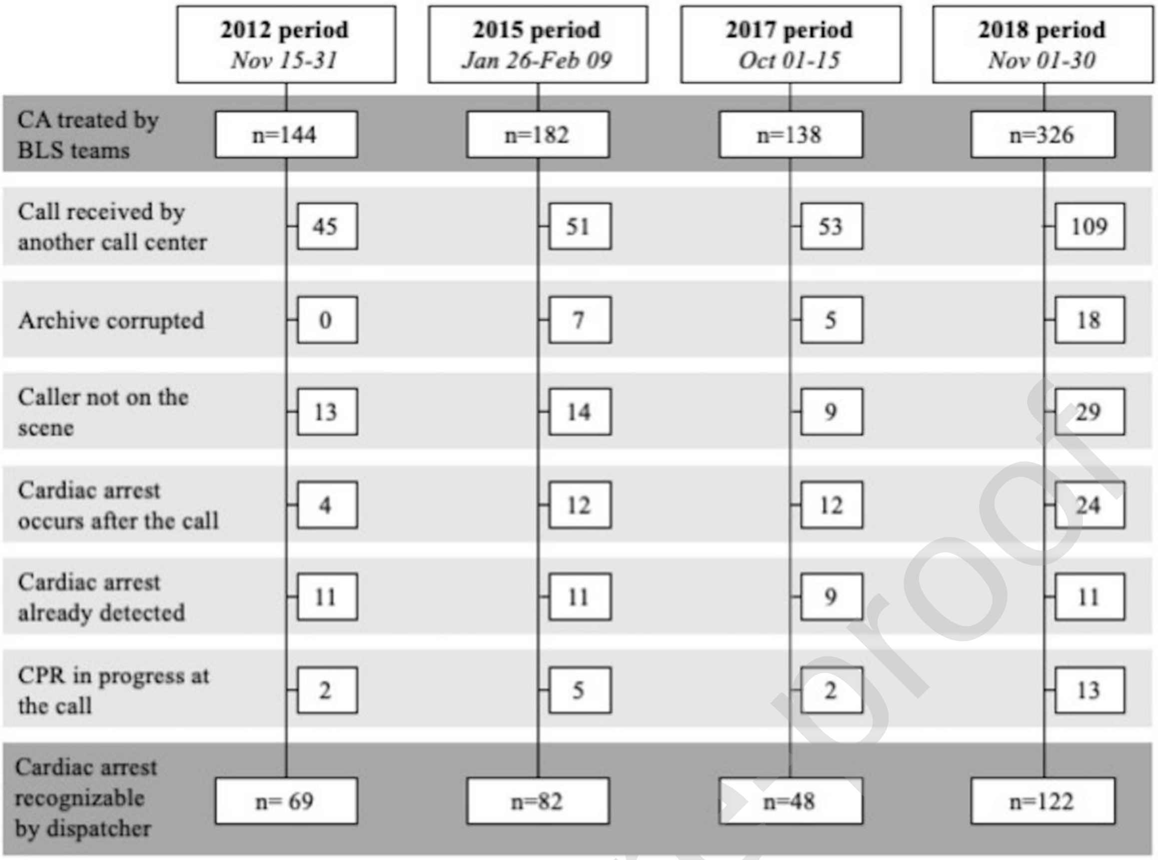
Table 3.

	n	%	*	†
Reasons for time wasted at the Public Safety Answering Point	73	*(59)*		
Dispatcher asked inappropriate questions	4	*(3)*		++
Caller stress	13	*(11)*		-
Caller did not answer questions or provided unnecessary details	18	*(15)*		+/-
Caller repeatedly asked to send help	20	*(16)*		+/-
Caller spontaneously gave his name and address	45	*(37)*		+/-
Time wasted between contacting the PSAP and EMD				+
Reasons for time wasted at the Emergency Medical Dispatch,	117	*(95)*		
Total time wasted for address acquisition	65	*(53)*		
The address did not exist in the computer database	5	*(4)*		++
Caller did not know the building access codes	5	*(4)*		+/-
Dispatcher misunderstood the spelling of a street name	6	*(5)*		+/-
Accent hindered comprehension	7	*(6)*		-
Caller did not know the address of his/her location	11	*(9)*		++
Dispatcher interrupted taking the address with questions	13	*(11)*		+
Caller did not answer questions or provided unnecessary details	37	*(30)*		+/-
Reasons for time wasted in the diagnosis of unconsciousness	57	*(46)*		
Difficulty moving a heavy patient	5	*(4)*		-
Unreliable caller responses	9	*(7)*		-
Dispatcher delayed asking about unconsciousness	13	*(11)*		++
Dispatcher interrupted the consciousness check with other questions	17	*(14)*		++
Caller had to move to check on the patient	19	*(15)*		-
Caller stress	21	*(18)*		-
Reasons for time wasted in determining no/abnormal ventilation	49	*(40)*		
Dispatcher stress	2	*(2)*		+
Crowd interfered with the evaluation	7	*(6)*		-
More than two Hand on Belly evaluations	9	*(7)*		++
Lost communication: the dispatcher called the caller back	9	*(7)*		-
Difficulty moving a heavy patient	15	*(12)*		-
Patient experienced cardiac arrest during the call‡	20	*(16)*		-
Unreliable caller responses	21	*(17)*		-
Reasons for time wasted in starting t-CPR	99	*(80)*		
Delay due to the installation of a defibrillator	1	*(1)*		+
Dispatcher feeling futility	10	*(8)*		+/-
Crowd interfering with caller gestures	12	*(10)*		-
Caller feeling futility	13	*(11)*		-
Caller went to get a neighbor for help	15	*(12)*		-
Dispatcher's explanations too long for performing the CPR	18	*(15)*		++
Caller stress	22	*(18)*		-
Dispatcher asked caller for patient medical history	30	*(24)*		+
Dispatcher asked caller to check for no flow, cold, and/or stiffness	42	*(34)*		+/-
Caller difficulty moving a heavy patient	47	*(38)*		-

Table 3. Frequency of reasons for wasting time at different time points during the telephone conversation for reporting a cardiac arrest in the 2018 cohort

**Color coding indicates wasted time due to caller (blue), dispatcher (green), or logistics and technology (yellow)*
†Improvements in practices were rated as imperative (++), possible (+), difficult (+/-), or impossible (-). Frequency did not predict the amount of time lost
‡or gasping at intervals <7 s at the beginning of the call

Figure 1: Flowchart of the selection of out-of-hospital cardiac arrest calls for analysis



CA Cardiac Arrest, CPR Cardiopulmonary Resuscitation, BLS Basic Life Support

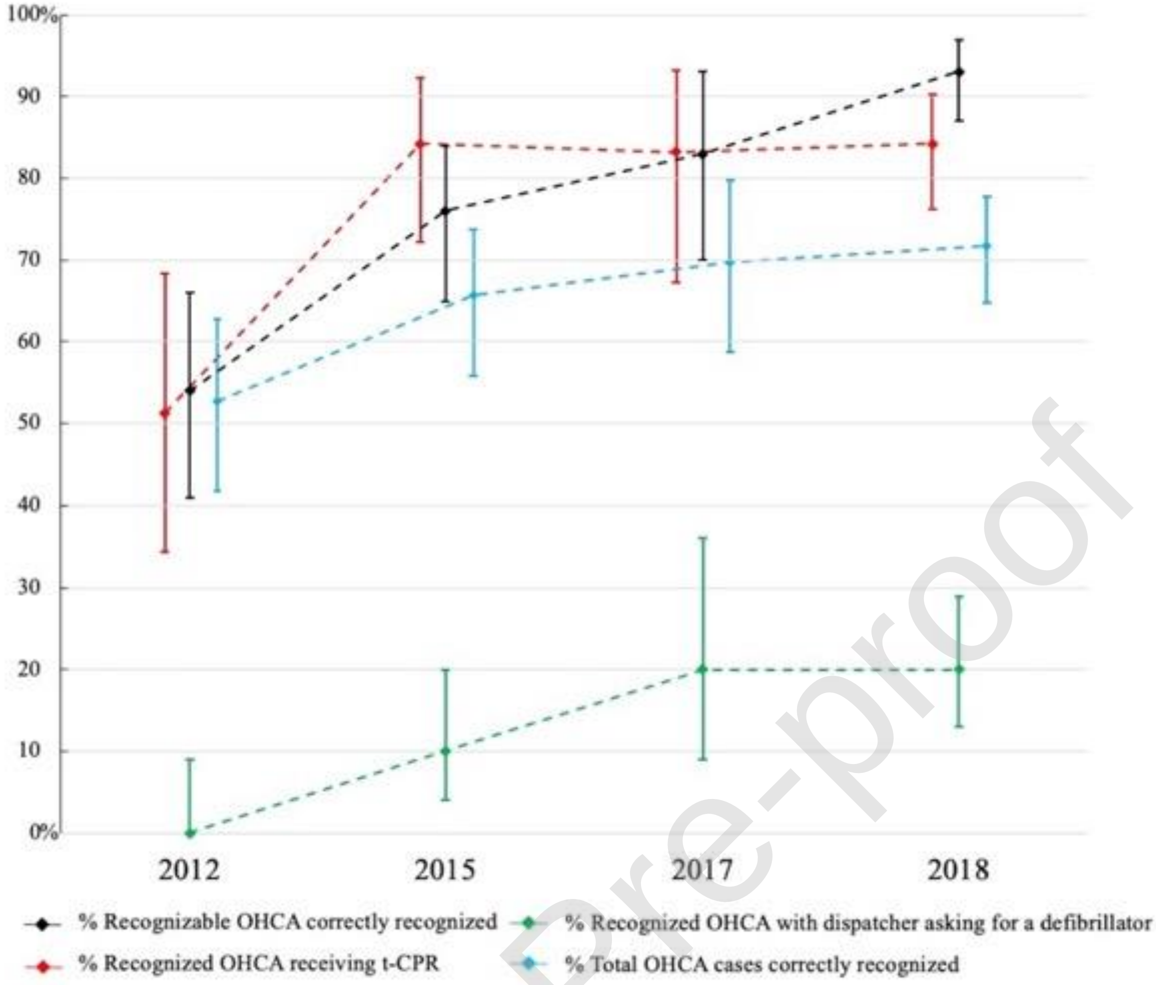
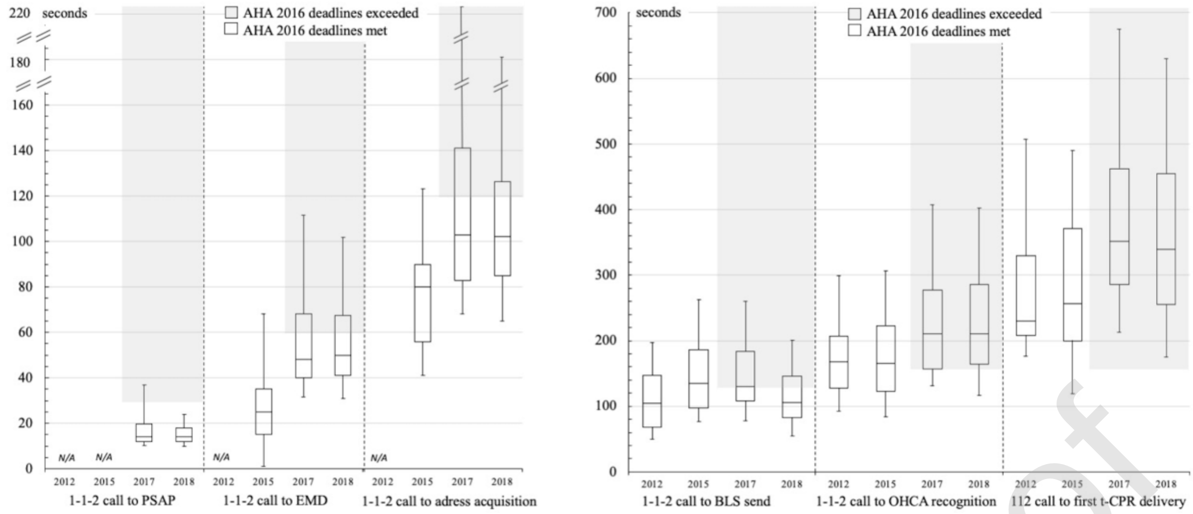


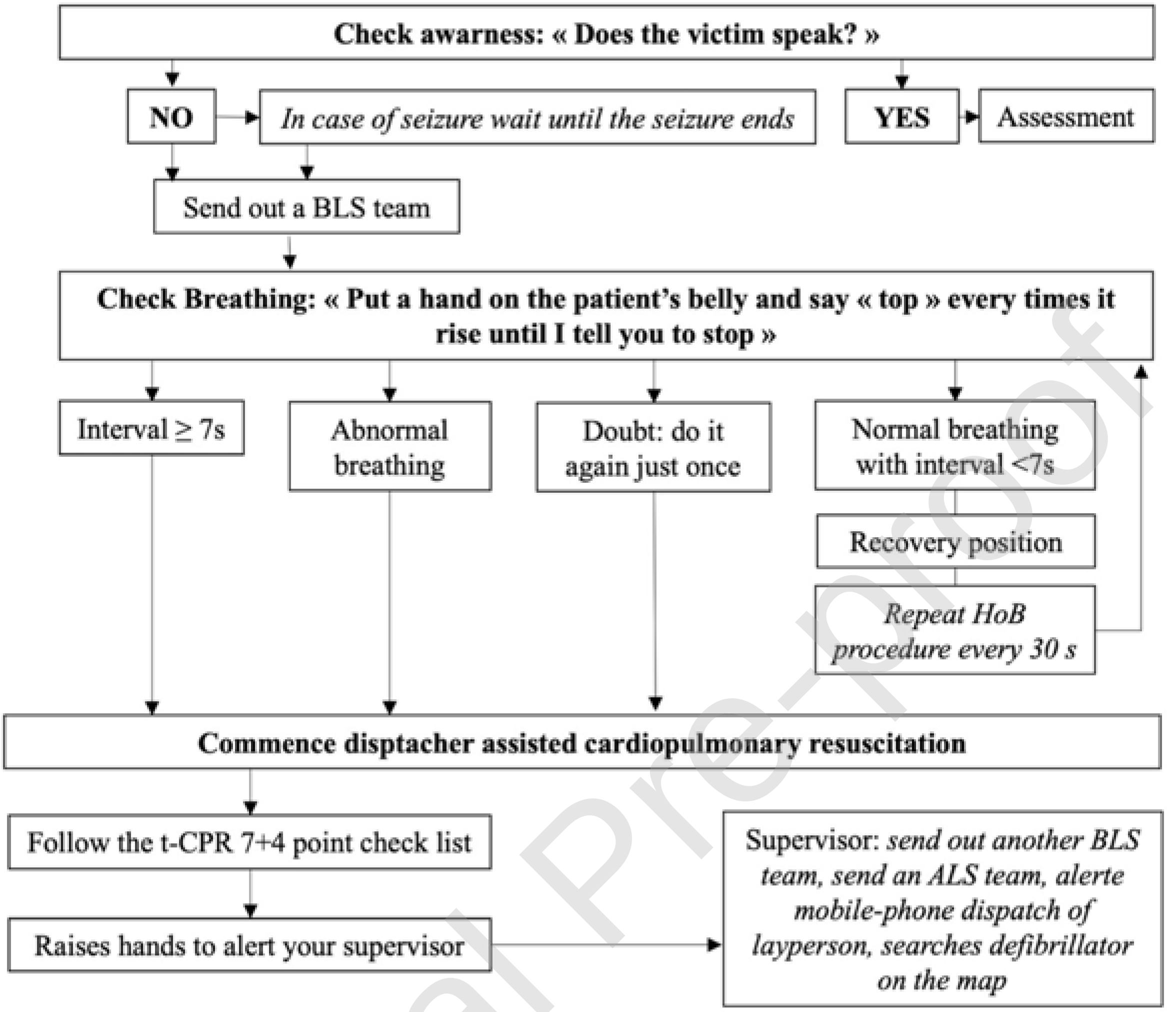
Figure 2 : Out-of-Hospital Cardiac Arrest detection and telephone-assisted Cardiopulmonary Resuscitation rates. *OHCA: Out-of-Hospital Cardiac Arrest; t-CPR: telephone Cardiopulmonary Resuscitation*



<u>Figure 3</u>: Time intervals (s) for the six steps of dispatch-Assisted cardio-pulmonary resuscitation, shown for each year included in the study. *PSAP: Public Safety Answering Point; EMD: Emergency Medical Dispatch; OHCA : Out-of-Hospital Cardiac Arrest; BLS: Basic Life Support Team; t-CPR : telephone-assisted Cardiopulmonary Resuscitation; AHA: American Heart Association*

Supplementary online data

Additional Figure 1: Hand on Belly algorithm



Two BLS teams are sent since we read "Warren SA, Prince DK, Huszti E, Rea TD, Fitzpatrick AL, Andrusiek DL, et al. Volume versus outcome: More emergency medical services personnel on-scene and increased survival after out-of-hospital cardiac arrest. Resuscitation. 2015;94:40‑8."

Additional Table 1: The 2012 list of 7+6 instructions and the 2019 list of 5+8 instructions for guiding telephone-assisted Cardio-Pulmonary Resuscitation (t-CPR)

2012 list of 7+6 instructions for guiding t-CPR

Processing Chest Compressions

1. The ambulance is on its way, I'll help you do chests compressions
2. Put your phone on speaker, and listen to me carefully
3. Lie the victim on the ground, with his back flat; extend the victim's arm at 90° to the side of the body
4. Kneel next to the victim, straddling his arm
5. Place your hands on top of each other, in the middle of the line that connects the 2 nipples, between the 2 breasts
6. Keep your arms straight, press as hard as you can every time I say « top ». Did you understand?
7. **« TOP TOP TOP ..... »** Make sure your buttocks are off your heels

Improving Chest Compressions

8. Now you say « TOP» every time you press down on the chest
9. Never stop, even when I'm talking to you, until help arrives and you are replaced. I'll stay on the phone with you.
10. Do you know if there is a defibrillator nearby, can you ask someone to get it?
11. That's very good, keep doing what you're doing; "help is coming soon"
12. Improving the technique:

    Release completely between compressions

    Keep up the pressing

    Press only with the heel of the hand

Keep your arms straight

13. Can someone replace you to make sure the compressions remain effective?

2019 list of 5+8 instructions for guiding telephone-assisted Cardio-Pulmonary Resuscitation

Processing Chest Compressions

1. Rescue is on the way, I'll help you to perform the fastest CPR massage possible
2. Is there a defibrillator nearby? Can you ask someone to go and get it?
3. Put your phone on speaker, and listen to me carefully
4. Lie the victim on the ground, with his back as flat as possible
5. Kneel next to the chest and place your hands, one on top of the other, between the two breasts. Press hard every time I say "top"; **"TOP TOP TOP TOP…"**

Improving Chest Compressions

6. Keep your arms straight, press harder "TOP TOP TOP TOP…"
7. Raise your buttocks off your heels
8. Now you say "TOP" each time you press
9. Keep up the pace, you can stop saying "TOP". Keep breathing
10. Never stop pressing, even when I'm talking to you, until help arrives and someone replaces you. I'll stay on the line with you. Press harder
11. That's very good, keep doing what you're doing, help is coming soon. Press harder
12. Improving the technique:

    Release completely between compressions

    Keep pressing hard

    Press only with the heel of the hand

Keep your arms straight

13. Can someone replace you to make sure the compressions remain effective?

<u>Supplemental material : Additional Table 2</u> Patients characteristics and outcome with missing data

		Period 2012 n=69	Period 2015 n=82	Period 2017 n=48	Period 2018 n=122	P value
PATIENT CHARACTERISTICS						
Male *(no missing data)*		45 (65)	49 (60)	30 (63)	71 (57)	0.74
Age, years *(m.d. (2012)=3)*		65 [51-79]	71 [58-84]	66 [55-81]	70 [55-81]	0.72
Out-of-Hospital Cardiac Arrest (OHCA) CHARACTERISTICS						
Location	home	45 (65)	65 (79)	41 (85)	99 (81)	0.31
(m.d. (2012)=6)	public /work place	18 (26)	17 (21)	7 (15)	23 (18)	
Traumatic cardiac arrest *(m.d. (2012)=2) (m.d. (2015)=1)*		4 (6)	6 (7)	2 (4)	7 (6)	0.95
Seizure at the call *(m.d. (2012)=2) (m.d. (2015)=1)*		2 (3)	3 (4)	3 (6)	6 (5)	0.86
CALLER CHARACTERISTICS						
Caller-patient link	None	3 (4)	18 (22)	7 (15)	35 (29)	0.24
(m.d. (2012)=35) (m.d. (2015)=10) (m.d. (2017)=11)	Close relative /family	31 (45)	61 (74)	31 (63)	87 (71)	
Ability to perform CPR	None	26 (38)	61 (74)	34 (71)	101 (83)	0.22
(m.d. (2012)=40) (m.d. (2015)=3) (m.d. (2017)=10)	First-aid /healthcare worker	3 (4)	18 (22)	4 (8)	21 (17)	
DISPATCHER WORK						
Breathing	Not realized	20 (29)	14 (17)	7 (15)	4 (3)	<0.001
assessment	Yes without HoB	23 (33)	17 (21)	1 (2)	20 (16)	
(m.d. (2012)=3)	Yes with HoB	21 (30)	51 (62)	41 (83)	99 (80)	
Number of Hand on Belly (HoB) tests *(on breathing assessment with Hob) (no missing data)*	1		25 (49)	22 (54)	46 (46)	0.64
	2	*N/A*	16 (31)	11 (27)	44 (44)	
	>2		10 (20)	8 (19)	9 (9)	
Breathing movements reported by caller or audible on the tape (%) *(m.d. (2012)=23) (m.d. (2015)=12) (m.d. (2017)=9) (m.d. (2018)=9)*		14 (20)	15 (18)	13 (27)	34 (28)	0.48
Recognizable OHCA correctly identified *(no missing data)*		37 (54)	62 (76)	40 (83)	113 (93)	<0.001
Correctly identified OHCA receiving t-CPR *(no missing data)*		19 (51)	52 (84)	33 (83)	95 (84)	<0.01
Total OHCA* cases correctly identified *(no missing data)*		50 (53)	78 (66)	52 (70)	142 (72)	0.01
Correctly identified OHCA with dispatcher asking for a defibrillator (%) *(m.d. (2012)=32) (m.d. (2015)=7) (m.d. (2017)=2)*		0	6 (10)	8 (20)	23 (20)	0.01
BASIC and ADVANCED LIFE SUPPORT						
CC ongoing at BLS arrival		25 (36)	51 (62)	35 (73)	101 (83)	0.01
Shock delivered by AED ≥1		15 (22)	15 (18.3)	14 (28)	32 (26)	<0.01
Survival until hospital admission		19 (28)	21 (26)	17 (35)	32 (26)	0.63

Discharge alive from hospital	5 (7)	3 (4)	4 (8)	9 (7)	0.12
DISPATCHER CHARACTERISTICS					
Dipatcher age, years *(m.d. (2015)=10)* *(m.d. (2017)=4)*	30 [28-33]	32 [30- 34]	33 [30-37]	30 [28-34]	0.05
Seniority at the EMD, years *(m.d. (2015)=9)* *(m.d. (2017)=4)*	4.0 [3.5-4]	1.4 [0.3-3.2]	3.0 [3-3]	2.7 [1.4-3.8]	<0.001