Telephone cardiopulmonary resuscitation, first responder systems, cardiac arrest centers, and global campaigns to save lives

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Purpose of review
The latest resuscitation guidelines contain a new chapter, which focuses on systems improving care for patients with out-of-hospital cardiac arrest (OHCA). In this article, we describe recent developments regarding telephone cardiopulmonary resuscitation (CPR), first responder systems, cardiac arrest centers, and global campaigns.

Recent findings
Telephone CPR has been implemented in many countries, and recent developments include artificial intelligence and video calls to improve dispatch assisted CPR. However, the degree of implementation is not yet satisfying. Smartphone alerting systems are effective in reducing the resuscitation-free interval, but many regions do not yet use this technology. Further improvements are needed to reduce response times. Cardiac arrest centers increase the survival chance after OHCA. Specific criteria need to be defined and professional societies should establish a certification process. Global campaigns are effective in reaching people around the world. However, we need to evaluate the effects of the campaigns.

Summary
Telephone CPR, first responder systems, cardiac arrest centers, and global campaigns are highlighted in the recent resuscitation guidelines. However, the degree of implementation is not yet sufficient. We do not only need to implement these measures, but we should also aim to monitor the systems regarding their performance and further improve them.

Keywords
cardiac arrest centers, first responder systems, telephone cardiopulmonary resuscitation, world restart a heart day

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) is the third leading cause of death in industrialized countries. When the brain is deprived of oxygen, vital structures are irreparably destroyed in as little as 3–5 min [1▪]. An immediate action by bystanders can reduce the critical delay until the arrival of the ambulance service and up to 100 000 additional lives could be saved each year in Europe [2,3,4▪], and the same applies to other parts of the world. The international resuscitation guidelines give recommendations for many different possible single measures during cardiac resuscitation and for the sequence of actions in different situations. The latest update of the guidelines added a completely new chapter focusing on a system-based approach [5]. Four out of five main topics in the new chapter address the need for earliest possible basic life support (BLS) including rapid defibrillation. One main topic is about cardiac arrest centers caring for patients after OHCA. This article aims to give an overview over the recent developments in the main topics of the chapter systems

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KEY POINTS

- Telephone cardiopulmonary resuscitation (T-CPR), volunteer first responder systems, cardiac arrest centers and global campaigns are part of a system-based approach and have been shown to improve survival after OHCA.
- Every dispatch center should establish a system monitoring the number of out-of-hospital cardiac arrest (OHCA) cases and the proportion of cases in which T-CPR was delivered, and the results should be published.
- Every geographical region should implement a smartphone-based alerting system, which is connected to an Automated External Defibrillator (AED) network, and publish their results in accordance with the new reporting standard.
- In every nation specific requirements and processes should be defined for cardiac arrest centers, and a certification process should be established.
- The effects of global campaigns should be evaluated, and the campaigns should be optimized based on the results.

saving lives except for the kids save lives topic, which is covered by a separate article in this issue of *Current Opinion in Critical Care*.

TELEPHONE CARDIOPULMONARY RESUSCITATION

Telephone cardiopulmonary resuscitation (T-CPR) is a highly effective intervention in which the rescue dispatcher instructs the caller how to perform cardiopulmonary resuscitation (CPR) until the emergency medical services (EMS) arrive. T-CPR increases the survival rate of OHCA patients and has been recommended in the resuscitation guidelines since 2010 [5,6▪].

Recent findings

The concept of T-CPR has grown in popularity over the last two decades and the scientific evidence, the development and implementation of this lifesaving strategy has increased tremendously [7].

However, the implementation status varies vastly. In a German prospective field study, all participating dispatch centers reported performing T-CPR and 78% of respondents supported making T-CPR mandatory. Notwithstanding, less than half of the participating emergency centers (73/44%) achieved a sufficient implementation rate (percentage of T-CPR for clearly recognized OHCA >80%). Reasons for the low rate included difficulty recognizing cardiovascular arrest over the phone and lack of training [6▪]. Furthermore, ambulance dispatchers reported on the impact of the coronavirus disease 2019 (COVID-19) pandemic on the performance of T-CPR: 34% stated that it had no impact and only 3% stated that it was temporarily not performed [8].

A meta-analysis conducted in 2022, which compared video-instructed dispatcher-assisted bystander cardiopulmonary resuscitation (V-DACPR) with conventional audio-instructed dispatcher-assisted bystander cardiopulmonary resuscitation (C-DACPR/T-CPR), showed significantly improved results regarding prehospital return of spontaneous circulation (ROSC) and patients' survival to hospital discharge. Under simulated resuscitation conditions, V-DACPR exhibited a higher rate of adequate chest compressions than C-DACPR [9▪].

In coordination with International Liaison Committee on Resuscitation (ILCOR), the European Resuscitation Council (ERC) recommends that emergency medical centers have systems in place to allow dispatchers to provide telephone CPR instructions for adult patients in cardiac arrest. ILCOR based this recommendation on very-low certainty evidence from 30 global observational studies. These studies compared the outcomes of patients who were offered telephone CPR instructions with the outcomes of patients who were not offered telephone CPR instructions [5].

Legal requirements, training, and standardization are important for standardizing T-CPR implementing it across countries [8].

FIRST RESPONDER SYSTEMS

Professional ambulance services do not commonly arrive at patients in OHCA within three to five minutes. Over many decades first responder systems with fire engines, police cars, and volunteers from first aid organizations aimed to reduce the resuscitation-free interval. The wide-spread use of mobile phones has enabled the development of systems in which volunteer responders are activated via their mobile phones when they are in the vicinity of a suspected OHCA. The first technological innovation was the use of the global system for mobile communications (GSM) to locate previously registered volunteers in case of suspected OHCA and alert them via short message service (SMS) [10]. These systems lack precise tracking of first responders (the accuracy is between 0 and 75 m) and there is no link back to the dispatch center. This means that the dispatch center does not receive feedback about mission takeover or arrival at the scene. The next ground-braking innovation was to use the built-in global positioning

system (GPS) in smartphones to locate volunteers and alert them via an app. This technology was implemented in 2012 and first mentioned in a study, which took place on the island Langeland in Denmark, were the median response time for the first volunteer arriving on site was 4 : 10 min and the median response time of the first responder bringing an AED was 5 : 47 min [11]. App based alerting technology results in shorter response times of the first responders [12] and has replaced text messaging alerts in many regions. The latest resuscitation guidelines recommend establishing lifesaving systems with two AEDs per km^2 and at least 10 first responders per km^2 [5] This recommendation is based on a Dutch study on a text message alerting system, which uses home and working addresses of volunteers, and which does not locate volunteer first responders using GPS [13]. The guidelines recommend using smartphone alerting systems to reduce the time to first compression and shock delivery, but very limited evidence is available regarding first responder density and first responder response times. Squizzato *et al.* performed a systematic review of mobile phone based alerting systems and found that relevant information regarding the alerting algorithm are not described in many studies [14]. More than thirty years ago a uniform reporting standard for studies on OHCA has been published [15], and many additional Ustein style templates have been published for specific situations [16]. However, no reporting standard has been published for studies in the field of smartphone alerting systems. Consequently, the report of performance data in publications in this field lacks relevant data: Some studies give estimated response times for first responders [17,18], other scientific reports give response times, but do not explain how these were measured [19,20]. 2022 an international consensus conference was held in Hinterzarten/Germany, with 46 researchers aiming to define a reporting standard for smartphone alerting systems. The group defined 68 items in five topics and elaborated definitions for the relevant parameters. Hopefully the more standardized approach in reporting data regarding research about smartphone alerting systems will foster comparability of systems and research results.

There are many open questions regarding first responder systems, which may be subject to upcoming research. The minimum qualification levels to register as a volunteer differs between systems. The resuscitation guidelines recommend including ''trained and untrained persons, firefighters, police officers, and off-duty healthcare professionals'', but today we do not have evidence that including untrained volunteers is better than requiring a higher qualification level. In the Italian region Emilia Romagna lay persons *without* BLS training can register [21]. The Heartrunner system in Sweden (Region Stockholm and Gotaland) requires that volunteers registering for the system state that they had taken part in a BLS course [22]. An emergency medical technician course with 48 h is the minimum qualification in the largest first responder system in Germany (Region of Lifesavers) [23▪]. The objective of a low (or even no) minimum qualification may be to have a high number of registered volunteers and thus a high first responder density, assumingly resulting in a high proportion of events with at least one first responder accepting the alert. Furthermore, one would expect shorter response times with higher first responder density. On the other side the intention of higher minimum qualifications may be to have high-quality BLS including ventilations being performed prior to the ambulance arrival. We do not know about the potential first responder density with either strategy, but if we compare recent publications, we find the following densities: 3.3 first responders (FR) per 1000 inhabitants and 0.65 first responders per km^2 in the Emilia Romagna region; 2.0 FR per 1000 inhabitants and 0.65 FR per km^2 in the Freiburg area (Region of Lifesavers). Stockholm and Gotaland regions in Sweden have much higher densities: 10.6 FR per 1000 inhabitants and 1.4 FR per km^2. Looking into the performance results we find interesting results: In Emilia Romagna first responders arrive prior to the ambulance in 2.8% of cases in which the system was activated (144 cases out of 5.073 system activations) [21]. In a recent publication from the Freiburg group, the number of cases in which the FR arrived before the ambulance is not given, but in about 50% of the cases (activation of the system) at least one first responder accepted the alarm and a median response time of <4 min was achieved [23▪].

The response times may not only depend on the first responder density. Other factors may contribute to this performance parameter. The alerting strategies and algorithms differ substantially among first responder systems. We need to understand the algorithms and investigate the resulting system performance to further improve the programs and achieve even shorter response times. One system in Germany uses escalating alerting strategy: First responders are located if the system is activated, and the nearest volunteer is alerted. If he or she does not respond or reject the call, the next one receives the invitation. Up to two first responders are sent to the emergency location [20]. The 'Swedish strategy' is different: Up to 30 volunteer responders are alerted within 1.3 km from the emergency location [22]. Some are requested to fetch an AED and the others are directed towards the patient. A higher number of

first responders being dispatched may reduce the time until the first volunteer arrives to provide BLS and until the first volunteer arrives carrying an AED. The median response times for volunteers who ran directly to the patient was 4.6 min and for those who fetched an AED it was 6.1 min. Although these are encouraging results, there may also be disadvantages of a strategy alerting such a high number of volunteers: Those who cannot contribute (either because there are already enough persons to perform BLS or because they arrive after the ambulance) may be demotivated and their willingness to answer calls in future may decrease. This effect may be even greater if volunteers are alerted at night. A recent study from Denmark revealed a significantly reduced response and acceptance rate for volunteer responders during nighttime [24].

Another strategy is established in the Region of Lifesavers system (using the FirstAED alerting system being in use in Germany, parts of Denmark and Canada). When a call is received with suspected cardiac arrest, and the dispatch center agent confirms activation of the alerting system, a complex algorithm is triggered automatically: The system receives the anticipated response time of the ambulance. Simultaneously the volunteers are being located via their alerting app. Those who are close to the emergency location receive an alarm request and accept or reject. Furthermore, they tell their app whether they will reach the patient site by car, by bicycle or by running. The system performs a real-time calculation using Google Maps for every first responder and with the specific mode of transportation. If the volunteer is expected to arrive after the ambulance, the system will reject him or her. The system distributes the tasks (go to patient, fetch AED) based on the anticipated travel times. Those four volunteers with the shorter travel times are selected. Although this system has a low first responder density response times of below four minutes could be achieved [23▪].

CARDIAC ARREST CENTER

Cardiac Arrest Centers (CAC) are hospitals that are specialized in the aftercare of prehospital resuscitated patients. In 2017, for the first time worldwide, quality criteria for CAC were defined in Germany: Under the patronage of the German Resuscitation Council (GRC), a working group of anesthesiologists, cardiologists, intensive care physicians and emergency medicine specialists defined basic requirements for CACs. The criteria were endorsed by the German Society of Anesthesiology and Intensive Care Medicine (DGAI), the German Cardiac Society (DGK) und der German Society of Medical Intensive Care and Emergency Medicine (DGIIN). The certification in Germany is supervised by members of the DGK and the GRC. In 2021, the criteria were modified and adapted to improve their implementability in everyday clinical practice and a revised set of criteria was published [25].

International guidelines also recommend further treatment of OHCA patients in a CAC [5]

Associations and societies at the European level are positioning themselves to establish uniform criteria for CAC as well [Association for Acute Cardio-Vascular Care of the European Society of Cardiology (AVCV), European Association of Percutaneous Coronary Interventions (EAPCI), European Heart Rhythm Association (EHRA), ERC, European Society for Emergency Medicine (EUSEM), and European Society of Intensive Care Medicine (ESICM)]. A position paper sets out minimum requirements for the handling of patients after cardiac arrest. To increase survival, guideline-based therapies and consistent organization of care should be implemented in other European countries in the future [26].

Recent developments

In Germany and neighboring German speaking countries, more than 100 hospitals are certified as CACs [27].

In 2022, data were published about the potential impact of the CAC certification on the admission behavior of emergency medical services. Three hundred and seventy-eight emergency physicians and paramedics being asked how much additional transport time they would accept to reach a CAC. The accepted transport time to reach a CAC was 16.3 min [95% confidence interval (CI) 15.2–17.3] [28▪]. International studies support this survey result. For example, studies in Ontario, San Diego, and Arizona failed to find an association between mean transport time and survival to hospital admission and discharge [29–32]. However, these studies did not examine the consequences of an extremely long additional transport time. For this reason, it is important to find out how additional transport time can be kept as low as possible with CACs and how close a net should be.

The German study also showed that 78.3% of the respondents expected the introduction of CAC certification to improve patient care. In addition, 78.8% of emergency physicians and paramedics support the introduction of CACs. 75.1% of respondents expect it to influence their admission behavior for prehospital resuscitated patients in the future. 78.3% of respondents expect the certification to improve the quality of care for prehospital resuscitated patients [29].

A systematic review of 35 studies from December 2021 examined the impact of CAC on survival in patients with nontraumatic OHCA and found a significant improvement in good neurological outcome with CAC treatment (adjusted odds ratio (aOR), 1.85 [95% CI, 1.52–2.26]) and a significant improvement in survival (aOR, 1.92 [95% CI, 1.59–2.32]). The effect was greater for patients with shockable rhythms and those without prehospital return of spontaneous circulation [33].

GLOBAL CAMPAIGNS TO SAVE LIVES

One prominent example of an awareness campaign to increase awareness about cardiac arrest and teach people how to react in such an emergency is the World Restart a Heart initiative.

The ERC initially established the first European Restart a Heart Day in 2013. Since 2018, under the leadership of the ILCOR, the concept has been expanded internationally, as the World Restart a Heart (WRAH) Day. The day has been scheduled annually around October 16, to achieve the goal of improving survival after cardiac arrest. [34]

The WRAH is being held under the theme ''All citizens of the world can save a life'' and ''Your two hands can save a life'', to draw attention to the importance of lay resuscitation worldwide. All seven global ILCOR councils (American Heart Association, European Resuscitation Council, Heart and Stroke Foundation of Canada, Australian and New Zealand Committee on Resuscitation, Resuscitation Council of Southern Africa, Inter American Heart Foundation and Resuscitation Council of Asia) and many other organizations are supporting the global initiative.

Developments over the years

In the first year of its existence, 2018, 675 000 people were trained and 12.7 million people were reached through social media due to the WRAH with the key phrase ''CHECK-CALL-COMPRESS''. In 2019, the main theme was ''iconic places'' and special events were held in public places on that day. Worldwide, 206 million people were informed via social media, and 5.4 million people were trained in resuscitation. [3]. In 2020, the WRAH was not possible in the same scale due to the global coronavirus pandemic. The initiatives implemented various creative digital strategies, such as the #MySongCanSaveLives campaign, where famous artists shared their songs that matched the resuscitation rate (100–120 BPM) on their social media platforms. In addition, activities were created that could be easily done at home, such as livestreams, celebrity videos and virtual reality apps [35].

Recent developments

As published in 2023 the WRAH could still be kept alive during the pandemic. The WRAH continued largely in the digital space in 2021, this time focusing on the survivors! Stories of survivors due to bystander CPR were presented using the hashtag #CPRSavedMyLife. The campaign reemphasizes the vital importance of out-of-hospital CPR. ILCOR and its collaborators actively spread the message about how many additional lives could be saved each year by starting CPR before emergency services arrive. Online and in-person training and awareness campaigns have been organized all around the world leading to more than 2 200 000 persons trained and at least 302 000 000 people reached by the WRAH global collaboration through print and digital media making it the highest-impact year since its inception [4▪].

Over the past few years, the WRAH awareness campaign has reached more than 190 countries and more than 200 million people [36]. The goal is to involve National Resuscitation Councils, national governments, and local authorities in WRAH, to raise awareness of the importance of CPR and AED bystander access, to educate as many citizens as possible, and to develop and promote new and innovative systems and policies to save more lives [5,37▪].

CONCLUSION

We need a system-based approach to improve the survival rate after out-of-hospital cardiac arrest. The chapter systems saving lives in the current resuscitation guidelines sets a strong focus on measures to improve life support during the time before the ambulance arrives. Recent developments are very promising: Telephone CPR is increasingly established (although there is still much room for improvement) and technological advances such as video calls and artificial intelligence may help to support bystanders. Global campaigns reach more and more people all over the world. Their effect on lay persons' engagement (participation in BLS courses, willingness to provide chest compressions) should be investigated. Smartphone alerting systems are rapidly evolving in the past years, and we have increasing evidence for increased survival chance when volunteers nearby the OHCA location are alerted via an app. The next steps will be to apply a reporting standard, which will be published soon, and to optimize strategies and algorithms to achieve the shortest possible response times. Admission of patients after OHCA to specialized cardiac arrest centers is recommended in the resuscitation guidelines. In each country a comprehensive set of criteria need to be published and on a national level, certification processes need to be established.

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Conflicts of interest

M.P.M. is chair of Region of Lifesavers (nonprofit organization), received speaker honoraria from Stryker, and holds shares (SmartResQ ApS, Denmark).
M.J. is a working group leader in the EU-funded network PARQ-COST, focusing on cardiac arrest research.
B.W.B. is treasurer of the European Resuscitation Council (ERC), Founder of the ERC Research NET, Chairman of the German Resuscitation Council (GRC), Member of the ''Advanced Life Support (ALS) Task Force of the International Liaison Committee on Resuscitation (ILCOR), Member of the Executive Committee of the German Interdisciplinary Association for Intensive Care and Emergency Medicine (DIVI), Founder of the ''Deutsche Stiftung Wiederbelebung'', Federal Medical Advisor of the German Red Cross (DRK), Member of the Advisory Board of the ''Deutsche Herzstiftung'', Co-Editor of ''Resuscitation'', Editor of the Journal ''Notfall + Rettungsmedizin'', Co-Editor of the Brazilian Journal of Anesthesiology. He received fees for lectures from the following companies: Forum für medizinische Fortbildung (FomF), Baxalta Deutschland GmbH, ZOLL Medical Deutschland GmbH, C.R. Bard GmbH, GS Elektromedizinische Geräte G. Stemple GmbH, Novartis Pharma GmbH, Philips GmbH Market DACH, Bioscience Valuation BSV GmbH, Becton Dickinson GmbH, Fundacja Polski Instytut Evidence Based Medicine.
NR is employed at the German Resuscitation Council.

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