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Review

Improving survival after cardiac arrest in Europe: The synergetic effect of rescue chain strategies

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Abstract

Sudden cardiac arrest is a global problem and is considered the third leading cause of death in industrialized countries. Patient survival rates after out-of-hospital cardiac arrest (OHCA) vary significantly between countries and continents. In particular, the 2021 European Resuscitation Council (ERC) Resuscitation Guidelines place a special focus on the chain of survival of patients after OHCA. As a complex, interconnected approach, the focus is on: Raising awareness for cardiac arrest and lay resuscitation, school children's education in resuscitation "KIDS SAVE LIVES", first responder systems – technologies to engage the community, telephone-assisted resuscitation (telephone-CPR; T-CPR) by dispatchers, and cardiac arrest centers (CAC) for further treatment in specialized hospitals. The Systems Saving Lives approach is a comprehensive strategy that emphasizes the interconnectedness of all links in the chain of survival following an OHCA, with a particular focus on the relationship between the community and emergency medical services (EMS). This system-level approach emphasizes the importance of the connection between all those involved in the chain of survival. It has a high potential to improve overall survival after OHCA. Therefore, it is recommended that these strategies be promoted and expanded in all countries.

Keywords: Out-of-hospital cardiac arrest, Systems Saving Lives, KIDS SAVE LIVES, Lay resuscitation, Chain of survival

Introduction

Cardiovascular disease and sudden cardiac arrest are global problems. Out-of-hospital cardiac arrest (OHCA) is the third leading cause of death in industrialized countries.[1] In 2017, the estimated annual incidence of OHCA treated by emergency medical services (EMS) was 40.8–100.2 persons per 100,000 habitants worldwide.[1] Survival rates at hospital discharge after OHCA are approximately 3% in Asia, 6.8% in North America, 7.6% in Europe, and 9.7% in Australia, representing very low rates.[2] In Europe, the annual incidence of OHCA ranges from 67 to 170 per 100,000 inhabitants.[3] Here survival rates at hospital discharge are on average 8%, and vary from 0% to 18%.[3] Some differences in survival and outcomes after cardiac arrest may be explained by differences in the availability and structure of health care.[3] The average time for arrival of the rescue service varies within the European countries as well as between urban and rural regions. The median response time of less than ten minutes for EMS in urban areas in Europe is reported to be achieved in only 32% of countries.[3] Nevertheless, even in countries with a well-developed emergency call system, it often takes more than 5 minutes for the EMS to reach the victim. In addition, the location at the time of cardiac arrest is predominantly at home or residence in 56.6–76.3% of the cases,[1] highlighting the importance of lay resuscitation. Early chest compressions and the use of automated external defibrillators (AEDs) are associated with increased survival.[4] In Europe, a range of 13% to 82.6% of cardiopulmonary resuscitation (CPR) by laypersons was reported in 2017, with a mean of 58%.[5]

The survival of the victim after OHCA depends significantly on the immediate initiation of CPR, since structures in the brain already begin to die irreparably after only 3–5 minutes.[6] The chain of survival describes the crucial steps required to respond to life-threatening emergencies such as an OHCA.[7] These links in the chain of survival include:

1. Early access to the emergency system: Rapid detection of cardiac arrest and alerting the EMS.
2. Early CPR: Immediate provision of chest compressions and, if necessary, ventilation to maintain blood circulation.
3. Defibrillation: Delivery of an electric shock to the heart to correct abnormal heart rhythms.
4. Advanced care by EMS and hospital medical staff: Advanced care and transport of the patient by EMS, specialized further treatment by medical professionals.[7]

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The survival chain aims to illustrate the interconnection between the key phases of resuscitation and emphasizes the necessity for all links to be effective in order to optimize survival chances.[7] Deakin extended the survival chain by identifying the specific links where interventions are most effective, as this is where the majority of patients survive.[8] The focus here should be on expanding and improving strategies in order to achieve the greatest possible benefit for patients.[8] Fig. 1 shows these main links of the chain of survival.

Strategies to improve survival after cardiac arrest

The chain of survival refers to all actions related to the survival of people who suffer from sudden cardiac arrest. In this context, the new Resuscitation Guidelines (2021) of the European Resuscitation Council (ERC) based on the International Liaison Committee on Resuscitation (ILCOR) 2020 consensus, placed a special focus on the issue of Systems Saving Lives. Moving away from the classic 4-link chain of survival, they instead developed a multicomplex concept that emphasizes the link between the broader community and the EMS.[9] This Systems Saving Lives approach aims to highlight the connections and interrelationships between the various actors and factors involved in the chain of survival. Special emphasis is placed on the following components: Awareness of CPR and defibrillation, community engagement technology, resuscitation training for school children, follow-up in specialized hospitals – cardiac arrest center (CAC) – and support of CPR through telephone guidance (telephone-CPR; T-CPR) by dispatch centers.[9]

Baldi et al. describe the OHCA as a three-dimensional model.[10] The survival of a patient after OHCA is influenced by three interconnected dimensions: Firstly, patient-related variables such as age, sex, cardiovascular risk factors, comorbidities, and medical therapy. Secondly, factors related to the OHCA event itself, including whether it is witnessed, the time of occurrence, or location, also impact the outcome. Lastly, the overall system involved in managing an OHCA patient, encompassing bystanders, EMS, hospitals, or the resuscitation network, contributes to survival chances. While certain patient and event variables are beyond control, the third dimension, the system, is unique in that it can be directly influenced and improved. Enhancing each component of the system – such as engaging bystanders, ensuring timely EMS response, and facilitating effective coordination among healthcare professionals, first responders, and the community – can positively impact the chances of survival for OHCA patients.[9–11]

The following sections describe each of the strategies used to increase survival after OHCA in more detail.

World Restart a Heart (WRAH): Raising awareness for cardiac arrest and lay resuscitation

The most important step in the victim's chain of survival is resuscitation by laypersons. Early chest compressions are associated with increased survival after OHCA.[6] Increasing the lay resuscitation rate to 70–80% is expected to result in a threefold increase in survival.[12] To permanently improve this lay resuscitation rate, it is important to raise public awareness of the importance of sudden cardiac arrest

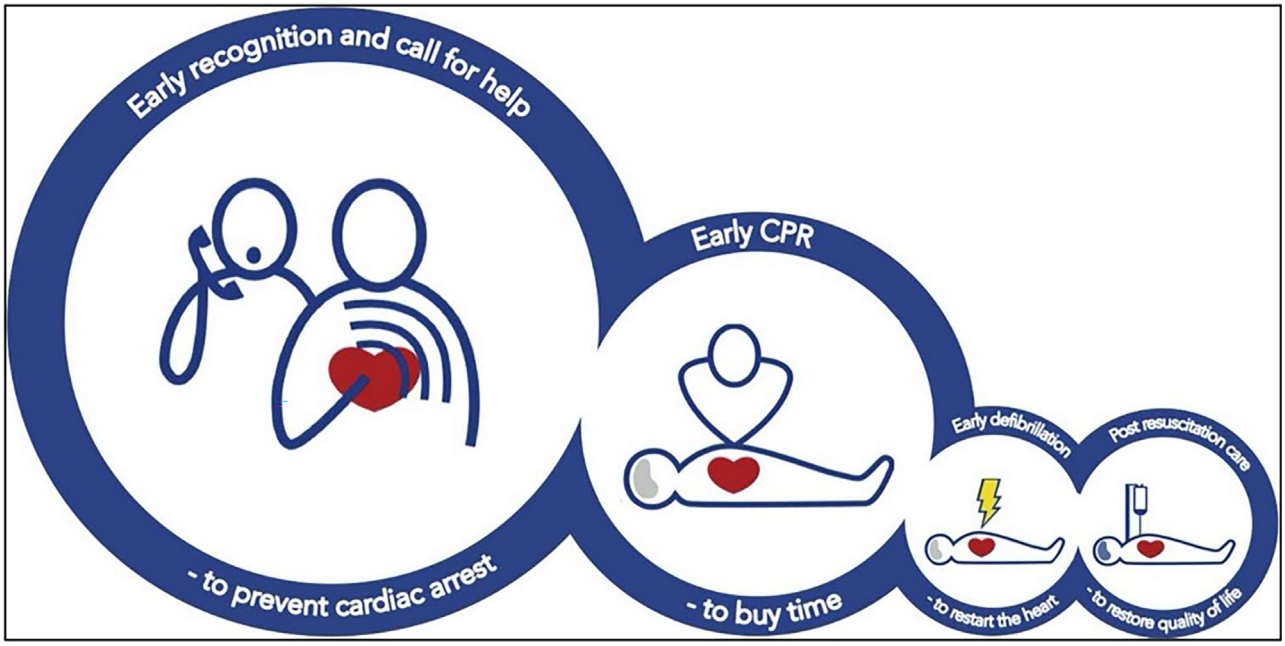

Fig. 1 – Chain of survival for out-of-hospital cardiac arrest. Reprinted from Deakin[8] with permission from Elsevier.

among the general population, e.g., through campaigns, awareness days, and by training as many people as possible in resuscitation techniques. An example of a high-profile awareness day is the WRAH Day, which takes place annually on October 16. This was originally developed from the European Restart a Heart Day, launched by the ERC in 2013.[13] In 2018, the ILCOR expanded this concept to its global network of resuscitation councils, making it a global initiative. Under annually changing mottos public mass resuscitation training, flash mobs or training of school children are conducted in addition to social media campaigns.[14–16] In 2019, 5.4 million lay people worldwide were trained in resuscitation techniques, besides more than 206 million people being reached via social media using the hashtag #worldrestartaheart.[14] Despite the Covid-19 pandemic and an increased focus on digital alternatives, the global WRAH collaboration trained more than 2.2 million people and reached at least 302 million people through print and digital media in 2021, its most successful year to date.[17]

Studies demonstrate that awareness campaigns, along with regular resuscitation training, lead to an increase in knowledge about OHCA and CPR.[12,18,19] It has been shown that the willingness of laypersons to start and perform CPR in the case of an emergency can be increased through publicity about the topic of resuscitation[20] and also raise the knowledge about AED.[21] In summary, public awareness campaigns can improve the survival of patients after OHCA.[22]

KIDS SAVE LIVES: School children's education in resuscitation

The World Health Organization (WHO) released a statement in 2015 highlighting the importance of pupil education in resuscitation. By introducing two hours per year of CPR instruction for all school children over the age of 12, the WHO expects to improve survival rates after sudden cardiac arrest.[23] Scandinavian countries, which show extremely high lay resuscitation rates, have been implementing this concept for years. In Denmark, for example, school children's teaching has been a fixed part of the curriculum since 2005. The increase in lay resuscitation rates in Denmark ensured an increase of survival after OHCA from 8% to 22% in 10 years through pupil's education as well as further widespread introduction of resuscitation training and awareness campaigns around the population.[12] This is more effective and beneficial than all other interventions and medications in improving survival. In Europe, teaching resuscitation to students is a legal requirement in only 6 countries and a recommendation in 23 countries.[9]

The international KIDS SAVE LIVES project recommends two hours of resuscitation training per year for all school children from grade 7. This training can take place in sports or biology classes or as part of project days and should consist of a theoretical and practical part. Training can be provided by physicians, medical assistants or medical students.[24] Lessons by specially trained teachers are also possible and, in comparison, appear to show better results, particularly in terms of knowledge and ventilation rate[25], as well as retaining high-quality CPR.[26] A combination of instructional videos and practical training on mannequins also achieves good results, including in long-term memory.[26]

Focus of the resuscitation lesson is on the key steps of "CHECK" – the correct recognition of cardiac arrest, "CALL" – making an emergency call, and "COMPRESS" – applying chest compressions at the correct depth and frequency. To serve as multipliers, school children should be encouraged to share their newly acquired knowledge with family and friends.[27]

Several factors potentially reduce survival after OHCA. Studies indicate that low socioeconomic status is also associated with low survival.[28,29] In addition, language barriers in the event of OHCA may also lead to a delay in recognition of cardiac arrest during the emergency call, thereby delaying the time to first chest compressions.[30] This highlights the importance of school-based training in resuscitation techniques.

A 2023 review by ILCOR examined and evaluated all existing international literature on training school children in resuscitation. The statement highlights the potential that training in resuscitation techniques in schools has on survival rates after OHCA. Training school children thus becomes a key strategy to permanently increase the lay resuscitation rate.[31,32] Key findings include:

- School-aged children are highly motivated to learn and to share their knowledge with family and friends, thus serving as multipliers.[31,32]
- Children as young as 4 years old are capable of learning the basic steps of resuscitation. From this age, they can recognize abnormal breathing and unconsciousness after training. This allows for an early start of resuscitation training. At the age of 6 children can explain how to dial the emergency number and share correct information about the emergency.[31,32]
- The necessary compression depth for chest compressions of 5–6 cm can be achieved from the age of about 10–12 years. The depth is mainly influenced by the child's body weight and body mass index. Nevertheless, even younger children should be taught the correct depth and frequency of compression, even if they do not reach them during training. This enables them to establish their knowledge in the long term and to instruct older people accordingly.[31,32]
- Regular training in resuscitation techniques will reinforce skills in the long term. If training is started with the youngest, they develop and anchor their skills and knowledge permanently.[31,32]

A current European project to further develop elementary school children teaching in resuscitation is the LIFEFORCE (Learning Initiative For Elementary school Fun Oriented Resuscitation Coaching Europewide, https://project-lifeforce.eu/) project. LIFEFORCE is a transnational and interprofessional European project specializing in a learning methodology to pre-train elementary school children aged 6 to 10 years in elements of resuscitation. The aim is to prepare elementary school students for later resuscitation lessons through innovative learning-by-doing activities (e.g., a compulsory lesson starting in 7th grade, KIDS SAVE LIVES) and to gain initial experience.[33]

Reports suggest that CPR skills among health students are often inadequate in Europe. A survey of European medical students showed large differences in knowledge and a lack of practical training. Therefore, the ERC calls for mandatory CPR training in health

studies, differentiated by profession, standardized according to their recommendations and regular refreshers.[34]

First responder systems: Using technologies to engage the community

First responder systems involve the public in a patient's chain of survival. These systems use mobile technology to alert first responders through the dispatch center parallel with EMS. This can be done through smartphone apps with location capabilities that alert registered first responders who are in the vicinity of a person with OHCA.[9] These systems can result in improvement in bystander CPR and a reduction in time to first chest compression.[35] Early defibrillation with public access AEDs by lay or professional first responders has also been shown to correlate with higher OHCA survival rates.[36] Several studies show that first responder alerting is associated with an increase in 30-day survival and a higher rate of survival with good neurological outcome.[11,35,37–39] Throughout Europe, first responder systems have been introduced in many regions, but without a uniform system.[40,41] Thus, there are systems that are available nationwide, or are limited only to individual districts whose systems are not compatible with each other. The possibility of first responder registration also differs, in some systems only persons with professional expertise in resuscitation are admitted, in other systems a registration with basic knowledge in first aid may be sufficient.[42]

First responder systems are particularly helpful in regions with low lay resuscitation rates and long EMS arrival times. A systematic review in 2020 analyzed the implementation and performance of these systems and their impact on patient outcomes. Among the included first responder systems, on average, first responders reached the scene after 4.6 (4.4–5.5) minutes to perform CPR. First responders arrived before the ambulance in 47% (34–58%) of cases and started CPR in 24% (23–27%) of the cases.[38]

It is unclear if first responders should be instructed via smartphone app to retrieve an AED before reaching the victim or not. A randomized study showed that when first responders were instructed to retrieve nearby AEDs, there was no significant increase in AED use compared to instructions to go directly to patients with OHCA to start CPR.[43] In contrast, other studies show that first responders who were first sent to an AED by text message resulted in a significant reduction in time to first defibrillation, increased resuscitation measures by laypersons and increased overall survival of patients with OHCA.[44]

First responder systems often primarily involve professionals, such as rescue service personnel or medical staff. There are also systems that mainly involve trained laypersons and are often used in residential areas.[45,46] Studies show that the activation of volunteers is associated with a higher probability of defibrillation by laypersons, especially in private households.[46] An analysis showed that potential risks that could arise when deploying first responders to private locations can be managed if appropriate safety precautions are taken. For example, first responder alerts are not carried out if there is a suspicion of potentially dangerous situations, such as crime or fire.[45]

Telephone – CPR: Assisted CPR by dispatchers

Insecurity is a common factor that prevents people from helping in emergency situations.[6] For this reason, the international resuscitation guidelines ascribe a special role to dispatchers. These guidelines call for the use of standardized criteria and algorithms in control centers for the rapid detection of cardiac arrest in the event of an emergency call. This is crucial to ensure rapid EMS intervention and immediate start of CPR by bystanders.[9] The immediate initiation of resuscitation measures can significantly increase the likelihood of survival for those affected.[12] Dispatcher guidance T-CPR or dispatcher-assisted CPR can reduce first responder inhibitions and significantly shorten the interval during which resuscitative efforts are not attempted.[47] Studies recommend that dispatchers instruct laypersons to perform chest compressions alone and to minimize the role of rescue breaths.[48] The ERC guidelines 2021, in agreement with ILCOR, also recommend focusing only on compression-only CPR in adults with suspected OHCA, less on respiratory support.[9] Telephone-assisted resuscitation by dispatchers is predicted to double survival.[11,47] Neurologically intact survival at discharge and after one month also shows an increase with dispatcher-assisted CPR.[49]

Cardiac arrest centers: Further treatment in specialized hospitals

A CAC is a certified hospital that specializes in the continuing care of patients after an OHCA by quality, specialization, expertise, and equipment. Since 2015, international guidelines have called for prehospital resuscitated patients to be treated in such specialized CAC.[50] This should enable the rescue services to assign patients in a targeted manner. The new ERC 2021 international resuscitation guidelines also reemphasize the importance of CAC in the Systems Saving Lives chapter.[9] Care of patients after OHCA in CAC is associated with improved survival and favorable neurological outcomes.[51]

Germany was the first country worldwide to establish uniform criteria for CAC certification in 2017. For this purpose, quality criteria and structural requirements for CAC were defined in a consensus paper, which was consented and published by the corresponding professional societies.[52] Subsequently, the first pilot hospitals were audited and certified in 2018. By 2023, more than 100 clinics nationwide have already been successfully certified as CACs.[53] The most important quality criteria for a CAC in Germany include:

- A special structure with the 24/7 availability of a suitable emergency department facility for resuscitated patients, the availability of a cardiac catheterization laboratory with the possibility of immediate primary percutaneous coronary intervention (PCI), the possibility of a direct takeover of resuscitated patients to the catheterization laboratory, the permanent availability of a place in the intensive care unit with proof of specialist intensive care, and the existence of a local quality circle for resuscitation care.[52]
- Ensuring adequate process quality with evidence of standard operating procedures (SOPs).[52]

Table 1 – Estimated impact on survival, modified from Böttiger et al.[11]

Intervention	Estimated impact on survival after out-of-hospital cardiac arrest (OHCA)
Increase lay resuscitation rates e.g., through public campaigns such as World Restart a Heart or KIDS SAVE LIVES	**threefold** increase
Assisted CPR by dispatchers	**double** increase
First responder systems	**1.2–2-fold** increase
Cardiac Arrest Centers	**double** increase

Legend to abbreviations: Out-of-hospital arrest (OHCA); World Restart a Heart (WRAH); Assisted-CPR by dispatchers (Telephone – CPR; T-CPR); Cardiac arrest centers (CAC).

– Quality assurance with evidence of standardized recording of the time course and course of treatment and the outcome until discharge.[52]

These criteria might also serve as guidelines for other countries. Efforts are also ongoing at the European level to establish uniform criteria and minimum CAC requirements for treatment modalities for patients after cardiac arrest.[54]

Table 1 provides a summary of the interventions and their estimated impact on patient survival after OHCA.

In this review, we have limited ourselves to the 5 key points of the System Saving Lives chapter. Additional information on these strategies can be found in Table 2.

In addition, there are further messages for clinical practice from ERC guidelines:

– Measuring the performance of resuscitation systems: Organizations and communities should assess their system performance and identify specific areas for improvement with the aim of enhancing overall effectiveness.[9] Using high-quality and unified registries to capture OHCA can identify country-specific knowledge gaps as well as potential opportunities for improvement in resuscitation system performance. Furthermore, cross-national comparison of different systems is possible.[55] High-quality registries may possibly improve survival after OHCA.[55]
– Low-resource settings: To understand diverse populations, etiologies, and outcome after OHCA in low-resource settings, resuscitation research should also include information on income levels and psychological and sociocultural perspectives on cardiac arrest.[9]
– Implementation of programs like European Resuscitation Academy and Global Resuscitation alliance: Programs that focus on improvements to the healthcare system and the individual links in the chain of survival to increase bystander CPR rate and survival after OHCA.[9]
– Implementation of early response systems, rapid response systems and medical emergency teams to reduce the incidence of in-hospital cardiac arrest and in-hospital mortality.[9]

Conclusion

Systems Saving Lives have greatest potential to improve survival and neurological recovery after OHCA. Targeted promotion of each strategy, in a complementary manner, can achieve a sustained and significant increase. The overarching goal is to increase the rate of lay resuscitation. Role models, such as Denmark, have already extensively expanded these systems and have been able to dramatically increase lay resuscitation rates and overall survival. Thus, these strategies are significantly more influential on the survival of patients after OHCA in terms of their effectiveness than all other EMS and hospital interventions.

CRediT authorship contribution statement

Lina Horriar: Writing – original draft, Conceptualization. **Nadine Rott:** Writing – review & editing. **Bernd W. Böttiger:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Lina Horriar and Nadine Rott are employees of the German Resuscitation Council. Nadine Rott is member of editorial board of Resuscitation plus and member of ILCOR Communications Committee. Bernd W. Böttiger 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.

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Appendix. Supplementary Data

Table 2 – Additional information on the 5 Systems Saving Lives strategies.

Strategy	**World Restart a Heart**: Raising awareness for cardiac arrest and lay resuscitation	**KIDS SAVE LIVES**: School children's education in resuscitation	**First Responder Systems**: Using technologies to engage the community	**Telephone – CPR**: Assisted CPR by dispatchers	**Cardiac Arrest Centers**: Further treatment in specialized hospitals
Current gaps	Lay resuscitation rates vary widely around the world. In Europe, there is a very wide range of 13%-82.6% of resuscitation by laypersons.[5] The incidence of OHCA and the probability of survival of the victims also vary between countries.[3]	Lay resuscitation rates vary widely between countries.[1] The introduction of CPR lessons for school children is regulated on a country-specific basis and often specific depending on the federal state. It is implemented differently around the world.[9]	The time between sudden cardiac arrest and the arrival of emergency services is an important factor in the patient's chance of survival after OHCA.[12] This time varies between countries and urban and rural areas.[3] To bridge the time, first responder systems can be used that send a registered first responder to the victim via app to start CPR.	Telephone instruction on CPR by dispatchers is often not mandatory. Particularly in the case of cardiac arrests that occur at home, this telephone instruction could help laypersons to perform chest compressions and bridge the time until the emergency services arrive.[9]	CAC ensure that patients receive high-quality further treatment in hospital after OHCA.[50] Standardized, worldwide criteria have not yet been defined.
How can the strategy close these gaps?	Awareness campaigns such as the WRAH aim to draw the attention of the general public to the issue of OHCA and the importance of lay resuscitation.[13] Furthermore, the practical application of CPR and AED can be practiced as part of action days.	The training of laypersons in resuscitation techniques is a key factor in increasing the lay resuscitation rate and increasing the survival rate of victims with OHCA.[4] Mandatory teaching of school children can increase the lay resuscitation rate and is low-cost and effective way.[23]	Registered first responders are alerted by the emergency services via smartphone app and sent to a nearby patient with OHCA.[9] This can reduce the time until resuscitation measures are started or the first time to shock via AED.[35] First responder systems bridge the time until the emergency services arrive.	Laypersons who feel unsure about chest compressions can be supported by the dispatcher.[6] By bridging the time until the emergency services arrive, the patient's blood circulation can be maintained. The introduction of mandatory T-CPR for dispatch centers is regulated on a country-specific basis and often specific depending on the federal state.	CAC as certified hospitals are specialized in the further care of patients after an OHCA, e.g. through quality, specialization, expertise and equipment. Criteria may include appropriate quality assurance, the provision of a cardiac catheterization laboratory, or adequate process quality with evidence of SOP.[52] There are no uniform criteria worldwide.

Table 2 (continued)

Strategy	**World Restart a Heart**: Raising awareness for cardiac arrest and lay resuscitation	**KIDS SAVE LIVES**: School children's education in resuscitation	**First Responder Systems**: Using technologies to engage the community	**Telephone – CPR**: Assisted CPR by dispatchers	**Cardiac Arrest Centers**: Further treatment in specialized hospitals
Examples or status worldwide	In 2019, a total of 5.4 million lay people have been trained on WRAH through successful activities such as public resuscitation training and flash mobs at iconic places around the world (e.g. the Colosseum in Rome, Italy and the Cologne Cathedral in Cologne, Germany).[15]	The WHO released a statement in 2015 highlighting the importance of pupil education in resuscitation worldwide. By introducing two hours per year of CPR instruction for all school children over the age of 12, the WHO expects to improve survival rates after sudden cardiac arrest.[23]	There are many first responder systems around the world that are designed specifically for each country. For example, there are differences between involving professionals, such as rescue service personnel or medical staff, or systems that that mainly involve trained laypersons (often in residential areas).[46]	ILCOR recommends that dispatch centers implement a standardized algorithm or criteria to immediately determine if a patient is in cardiac arrest at the time of the emergency call. It is further recommended that dispatch centers have systems that allow dispatchers to provide resuscitation instructions.[9]	Since 2015, international guidelines have called for prehospital resuscitated patients to be treated in such specialized CAC.[50] Requirements for CACs have so far been defined on a country-specific basis. To date, CAC have only been introduced in a few countries.[54]
Status or efforts in Europe	The ERC launched in 2013 the "European Restart a Heart (ERAH)" initiative to raise awareness on OHCA and lay resuscitation.[13] The ILCOR expanded the ERAH in 2018 to its global network of resuscitation councils and named it WRAH. The first WRAH in 2018 took place under the motto "All citizens of the world can save a life."[14]	Denmark introduced schoolchildren's education in CPR already in 2005. The introduction of compulsory teaching and further lay training in the population increased the lay resuscitation rate from 21% to 45% in 10 years. The survival rate after OHCA also rose from 8% to 22%.[12]	Throughout Europe, first responder systems have been introduced in many regions, but without a uniform system. Thus, there are systems that are available nationwide, or are limited only to individual districts whose systems are not compatible with each other.[41]	The concept of a telephone manual for resuscitation was developed in the USA in the 1970s. Some countries adapted this concept and optimized it for their specific EMS systems.[56]	In 2017, Germany was the first country in the world to define standardized criteria for CAC certification. To this end, quality criteria and structural requirements for the CAC were defined in a consensus paper, which was agreed and published by the relevant professional associations.[52] Efforts are also ongoing at the European level to establish uniform criteria and minimum CAC requirements for treatment modalities for patients after cardiac arrest.[54]

Legend to abbreviations: AED – automated external defibrillator; CAC – Cardiac arrest center; CPR – cardiopulmonary resuscitation; ERAH – European Restart a Heart; ERC – European Resuscitation Council; ILCOR - International Liaison Committee on Resuscitation; OHCA – out-of-hospital cardiac arrest; SOP - Standard operating procedure; T-CPR - Telephone CPR; WHO – World Health Organization; WRAH – World Restart a Heart.

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