

2020 Korean Guidelines for Cardiopulmonary Resuscitation. Part 9. Education and system implementation for enhanced chain of survival.

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Authors: Department of Emergency Medicine, Kyungpook National University School of Medicine, Daegu, Korea.

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Clin Exp Emerg Med Clin Exp Emerg Med 3081 ceem 101657493 CEEM Clinical and Experimental Emergency Medicine 2383-4625 The Korean Society of Emergency Medicine PMC8171173 PMC8171173.1 8171173 8171173 34034453 10.15441/ceem.21.029 ceem-21-029 1 Guideline 2020 Korean Guidelines for Cardiopulmonary Resuscitation. Part 9. Education and system implementation for enhanced chain of survival <http://orcid.org/0000-0002-3773-8047> Lee Mi Jin 1 Shin Tae-Yong 2 Lee Chang Hee 3 Moon Jun dong 4 Roh Sang Gyun 5 Kim Chan Woong 6 Park Hyo Eun 7 Woo Seon Hee 8 Lee Seung Joon 9 Shin Seung Lyul 10 Oh Young Taeck 11 Lim Yong Su 12 Choe Jae Young 1 Na Sang-Hoon 13 Hwang Sung Oh 14 on behalf of the Steering Committee of 2020 Korean Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care 1 Department of Emergency Medicine, Kyungpook National University School of Medicine, Daegu, Korea 2 Department of Emergency Medicine, Asan Chungmu General Hospital, Asan, Korea 3 Department of Emergency Medical Technician, Namseoul University, Cheonan, Korea 4 Department of Emergency Medical Service, College of Health & Nursing, Kongju National University, Gongju, Korea 5 Department of Emergency Medical Services, Sun Moon University, Asan, Korea 6 Department of Emergency Medicine, Chung-Ang University College of Medicine, Seoul, Korea 7 Division of Cardiology, Department of Internal Medicine, Healthcare System Gangnam Center, Seoul National University Hospital, Seoul, Korea 8 Department of Emergency Medicine, The Catholic University of Korea College of Medicine, Seoul, Korea 9 National Medical Emergency Center, National Medical Center, Seoul, Korea 10 Department of Emergency Medicine, Inha University College of Medicine, Incheon, Korea 11 Department of Emergency Medicine, Seoul National University College of Medicine, Seoul, Korea 12 Department of Emergency Medicine, Gachon University College of Medicine, Incheon, Korea 13 Department of Internal Medicine, Seoul National University College of Medicine, Seoul, Korea 14 Department of Emergency Medicine, Yonsei University Wonju College of Medicine, Wonju, Korea Correspondence to: Mi Jin Lee Department of Emergency Medicine, Kyungpook National University School of Medicine, 130 Dongdeok-ro, Junggu, Daegu 41944, Korea E-mail: emmam@knu.ac.kr 5 2021 21 5 2021 8 Suppl 383026 S116 S124 7 3 2021 7 3 2021 28 3 2021 21 05 2021 11 06 2021 12 06 2021 Copyright © 2021 The Korean Society of Emergency Medicine 2021 <https://creativecommons.org/licenses/by-nc/4.0/> This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>). pmc-status-qastatus 0 pmc-status-live yes pmc-status-embargo no pmc-status-released yes pmc-prop-open-access yes pmc-prop-olf no pmc-prop-manuscript no pmc-prop-legally-suppressed no pmc-prop-has-pdf yes pmc-prop-has-supplement no pmc-prop-pdf-only no pmc-prop-suppress-copyright no pmc-prop-is-real-version no pmc-prop-is-scanned-article no pmc-prop-preprint no pmc-prop-in-epmc yes pmc-license-ref CC BY-NC MAJOR CHANGES This chapter periodically

updates the evidence-based education and system implementation (EIT) guidelines with regard to reflecting evolving best training strategies on how best to implement successful resuscitation programs in Korea. A major change in the EIT section of the 2020 Korean guidelines for cardiopulmonary resuscitation (CPR) reflects an extension of the revised scope from the previous exclusive focus on education to the inclusion of the current system implementation. As the educational approaches are the core links among their implementation into practice, we provide the components of education in resuscitation at a more advanced level, based upon the survival environment. This extension highlights the importance of social competence for CPR education and a sudden cardiac death management system as a key element in constructing and realizing the survival environment, as newly described in the 2020 Korean CPR guidelines. The EIT Task Force conducted 16 systemic reviews applying the GRADE (Grading of Recommendation, Assessment, Development, and Evaluation) guidance [1 , 2]. The EIT of the present guidelines describes the consensus on scientific evidence and treatment recommendations of the 16 major issues that have been reviewed by the International Liaison Committee on Resuscitation in 2020 and revised to be compatible with the current status in South Korea.

The updated topics include the comprehensive factors to construct integrated survival outcomes based on the latest technology-enhanced training to teach resuscitation (e.g., self-directed CPR training, blended learning, contactless edu-technology, gamified learning, and virtual reality environment, etc.), the use of social networks and mobile phone technologies to notify volunteer bystanders, and strengthening the role for emergency dispatchers. In addition, early warning scoring and the rapid response team (RRT) for preventing cardiac arrest in hospitals, high-performed paramedic CPR with ongoing reinforced and continuous quality improvement regarding advanced resuscitation, and conditional recommendation of the termination of resuscitation (TOR) rules that should be reflected in the prehospital and emergency medical system (EMS) are updated [3 - 5].

Survival after cardiac arrest is determined by distinct factors depending on the circumstances in which sudden cardiac death occurs. Specific to out-of-hospital cardiac arrest (OHCA), rapid defibrillation and bystander CPR by the witness is a critical determinant of survival. For in-hospital cardiac arrest (IHCA), the same factors, as well as the early recognition of the possibility of cardiac arrest, are crucial. Patients usually show signs and symptoms of deterioration before cardiac arrest event. The rapid response system is a program designed to improve the safety of patients whose condition is worsening [6]. Thus, defining the most effective means of resuscitation education is similar to setting and achieving the goal of enhancing the survival rate in cardiac arrest patients.

The chain of survival has been extended to the Utstein formula for survival, which includes the prevention of cardiac arrest [5 , 7]. The addition of spaced learning (education or retraining frequently separated by longer periods of time) or booster training to resuscitation courses based on new education methodologies and technological advancement seems to be more effective skill retention than massed learning (education provided close in the whole time) [8 , 9]. In the event of an emerging infectious disease such as the pandemic coronavirus disease 2019 (COVID-19), several contactless education platforms have been developed and commercialized in Korea, taking into account the local accessibility and circumstances that hinder face-to-face training. The COVID-19 guidelines are updated based on evolving knowledge and experience in the epidemic [10 , 11].

It is very important to teach the technical skills of performing resuscitation at all levels. The specific educational needs of these different target groups (from citizens, first responder to health care clinicians) exist in series, depending on individual and organizational CPR competency requirements. The required competency level determines the CPR training interval, frequency, need for retraining, and programs level (from basic to advanced life support [ALS] levels). Understanding the clinical personnel's exposure or general experience on OHCA outcomes may inform training strategies. It also focuses on ALS training for paramedics with relatively little experience in managing cardiac arrest for high-quality resuscitation treatment.

The system guidelines for cardiac arrest treatment and their implementation suggest a novel TOR model that can be applied in the prehospital field and early phase, in addition to managing the RRT for preventing cardiac arrest in hospital. This guideline also proposes an integrated management of cardiac arrests in the community with monitoring strategies for the respective cardiac arrest registry. The following are the contents of the core pyramid of ESI for the enhanced chain of survival (Fig. 1).

These EIT guidelines focus on all steps in the continuum of care to improve cardiac arrest survival; to increase the proportion of patients with OHCA who receive immediate bystander CPR and early defibrillation; to prevent IHCA by RRT implementation, and to measure the resuscitation team performance and resuscitation outcomes. To enhance the prognosis of survival after cardiac arrest, it is necessary to have a workforce in the local community, resuscitation instructors and instructor trainers, guideline developers, and an integrated system of relevant organizations.

The chain of survival emphasizes early recognition of cardiac arrest/activation of the emergency response system, high-quality CPR, early defibrillation, advanced resuscitation support, and post-cardiac arrest care/rehabilitation. For OHCA, the main contributors are effective bystander CPR and early use of public access defibrillator (PAD). Emergency response system development, layperson and dispatcher training in the recognition of cardiac arrest, public education promotion, widespread PAD availability, and tele-communicator instructions are all important components of this step in OHCA setting. In addition, the following should be conducted for IHCAs: prevention and early response to cardiac arrest via the preemptive management of the rapid response system, efficient management of the CPR team, control of ALS training for hospital staff, and quality improvement activities for an enhanced chain of survival related to CPR in hospitals [7]. Lastly, while long-term recovery after cardiac arrest indicates good neurological prognosis, it includes cognitive, physical and psychological rehabilitation and recovery that targets the patients, family, and healthcare providers [12 , 13].

As part of the prevention and treatment of cardiac arrest in the entire country or local community, the system level takes into account the following factors: the proportion of witnessed bystander CPR and PAD use [14 , 15], intervention of prehospital or in-hospital therapeutic hypothermia (or targeted temperature management), and use of automated mechanical CPR devices or feedback devices [16 , 17]. The 2020 resuscitation guidelines recommend that key indicators be evaluated, while specific goals to enhance the performance status have been set for the EMS system, local community, and medical institutions providing cardiac arrest treatment (Class IIa, Level B-NR). However, as the current situation in South Korea involves separate management of OHCA and IHCAs, it may be reasonable for integrated social managements to implement strategies for enhanced survival outcomes and increasing bystander CPR.

A cardiac arrest registry is the essence of measurement. Local communities and EMS systems should establish and monitor the performance data on the social contributors of cardiac arrest survival and related processes. This involves data registration research on all steps of cardiac arrest and patient outcomes at regional community or nationwide levels [11 , 18]. Continuous measurements will determine if implementing changes leads to improvements. To achieve this, a database should be constructed to integrate registries at the local government, firefighting department, hospitals, national emergency medical center, and the Ministry of Health and Welfare data. In South Korea, the Korea Disease Control and Prevention Agency conducts research to collect and analyze the data on OHCA cases that are then applied in the national statistics. In the US, patient registration systems based on emergency centers have been established. One is the registry for IHCA (Get With The Guidelines-Resuscitation) [19] and the others are statistics for OHCA (Cardiac Arrest Registry to Enhance Survival or Resuscitation Outcomes Consortium Cardiac Registry) [20]. Data from these systems are essential in local community liaisons, monitoring quality improvement activities, managing quality indicators for quality improvement, and successfully enhancing the cardiac arrest survival rate in the local community.

The role of dispatchers or tele-communicators that connect the active EMS system and the general public in emergencies is the critical link in the chain of survival of OHCA. CPR performed by witnesses with the guidance of dispatchers (telephone-assisted CPR or dispatcher-assisted CPR) increases the rate of witness resuscitations in adult OHCA patients. However, it is difficult to accurately determine whether cardiac arrest has occurred in the field over the phone. Dispatchers accurately identify cardiac arrests over the phone in about 70% of cases [21]. If the suspected diagnosis of cardiac arrest is incorrect, the patients will receive inappropriate chest compression or CPR will not begin. Programs that improve the quality of dispatcher-assisted CPR and the feedback from physicians to dispatchers have improved the outcome of cardiac arrest patients. To be able to deliver the CPR guidance over the phone, dispatchers should complete a specific educational program [22]. Specific training of dispatchers on how to deliver telephone-assisted CPR can lead to improved cardiac arrest recognition, reduction of misinterpretation of agonal respiration, increased rate of patients receiving chest compressions, and a shorter time to compression.

We recommend that dispatchers use a standard algorithm to determine cardiac arrest situations through emergency calls (Class I, Level C-LD). To maximize the rate of resuscitation via telephone-assisted CPR, efforts should be made towards the development and active use of guidelines for dispatchers and scripted questions (to determine if a victim is unresponsive with abnormal breathing), and quality improvement through evaluating the debriefing after such telephone instructions and how to receive accurate feedback [23 , 24]. It is suggested that any dispatchers receive education for potential cardiac arrest situations that include the following: 1) recognizing a cardiac arrest; 2) encouraging the willingness of rescuers to perform CPR and notifying their safety checks; 3) providing instructions to perform chest compression-only CPR and to use an automated external defibrillator (AED); 4) helping the EMS to reach the location of the incident [25 , 26].

Education about communication during basic life support (BLS) is important in order to overcome barriers that rescuers might experience in performing CPR and use of the AED. There are three main barriers: personal factors (emotional barriers, most often panic, but also socio-economic factors); CPR knowledge (skill deficits, fear of damage or doing something wrong); and procedural issues (e.g., recognition of cardiac arrest, location of AED) [27 - 29]. Addressing these barriers and enablers to starting CPR might increase the willingness to help those in a life-threatening situation.

Treatment recommendation has not changed since 2010 (strong recommendation, low-certainty evidence). To increase willingness to perform CPR and use AED, laypersons should receive training. CPR training should include the recognition of gasping or abnormal respiration as a sign of cardiac arrest. The EMS dispatcher should provide CPR instruction to callers who report cardiac arrest. If unwilling or unable to perform mouth-to-mouth ventilation, rescuers should be instructed to continue compression-only CPR.

Use of feedback devices during resuscitation training can be effective in improving CPR performance. Since the last search in 2015, based on the evidence of simulation studies and certain clinical studies regarding the use of feedback devices in CPR education, these treatment recommendations have not changed. We suggest the use of feedback devices that provide directive feedback on chest compression rate, depth, decompression, and hand position for improving the CPR performance. If a feedback device is not available, it may be helpful to use a tonal guidance including music or metronome for feedback to only improve the chest compression rate (Class IIa, Level B-R).

The survival of prehospital cardiac arrests is influenced by a range of factors, and one of which is to provide high-quality resuscitation. Appropriate provision of prehospital resuscitation is an important element in determining good neurological prognosis from OHCA [30]. Understanding the impact of ongoing exposure or experience on patient outcomes from OHCA can help with staffing and training strategies. The exposure of EMS personnel is associated with improved short-term survival outcomes [31 - 33]. In order to increase the level of CPR experience, the national agency or local

community should build organically interconnected systems to educate EMS providers, paramedics, relevant educational institutions, and interhospital emergency medical directors through participation in CPR situation or supervising their procedure-focused advanced training.

Unlike the medical staff in hospitals that frequently encounter cardiac arrest patients, field EMS practitioners, including paramedics that provide treatment to OHCA, are relatively less exposed to actual cardiac arrest management cases. It is reasonable for EMS systems to monitor provider exposure to resuscitation to implement strategies to address issues of low exposure (Class IIb, Level C-LD). Thus, for the effective treatment of OHCA patients, EMS directors are advised to do as follows: 1) manage the experience or exposure of EMS personnel in resuscitation situations; 2) develop strategies, if possible, to address the problem of lack of resuscitation experience, or form a resuscitation team to include members with experience, especially with a recent resuscitation.

High-quality resuscitation training is essential for health care providers (HCPs) at all levels from BLS to ALS, for children and/or adults, depending on their workplace requirement for CPR competencies. Considering the medical staff at hospitals that work in departments with little exposure to cardiac arrest cases, a plan for certified resuscitation education should be developed. A meta-analysis of related studies has shown that resuscitation teams with one or more members having previous participation in an ALS course improve survival outcomes. It is reasonable for HCP to take an adult ALS course or equivalent training. At least one member of the in-hospital resuscitation team should be included in the certified ALS course, while medical staff and HCPs working in a department with higher CPR incidence should provide ALS training in addition to BLS as part of the certified or complementary education (Class IIb, Level C-LD).

Simulation in resuscitation training is widely used and is a well-established educational strategy. It facilitates contextualized learning relating to learner's reality. Learning CPR can be supported by the use of smartphones, tablets, etc. by using apps and social media, as well as feedback devices. These learning modalities may be teacher-independent. They improve retention and facilitate competency assessment in CPR. The 2020 guideline recommends using e-learning as part of the blended learning approach to reduce the time for conventional face-to-face education in advanced resuscitation. This requires comprehensive management of instructor-led lectures, simulation practices, and testing of conventional education (Class IIa, Level C-LD).

Taking into account these characteristics, learning objectives need to be defined for participating individuals or CPR teams, as well as choosing the adequate equipment. The use of high-fidelity manikins for continuous ALS programs can be effective for learners at training centers with available infrastructure and trained personnel (Class IIa, Level C-LD). If high-fidelity manikins are not available, the use of low-fidelity manikins that are suitable for the standard programs to achieve the educational goals may be considered (Class IIb, Level C-LD). Additionally, the latest tablet-based simulation apps combined with the use of low-fidelity manikins may be suitable alternative at reasonable cost for simulation during resuscitation training.

As cardiac arrest cases are, by nature, not frequently experienced, it is difficult to develop alternative cases for educational purposes. However, advances in technology have allowed us to use new resources for teaching CPR over the past few years [34 , 35]. Access to medical content has never been easier because of the ubiquitous availability of the internet. Gamified learning (e.g., virtual and augmented reality, smartphones or tablet apps simulating monitors) can be turned into a compression feedback device or become a simulated monitor. Serious games on mobile devices engage CPR learners differently than traditional classroom lessons [35 - 38]. Virtual learning environments are recommended to be used for pre-course e-learning, as part of a blended learning approach, or self-learning independent of time and location for all levels of courses [39 , 40]. Therefore, these devices and programs should be included in future CPR educational approaches and combined with face-to-face education (Class IIb, Level B-NR). It might be possible to integrate training related to simulated patients in virtual or augmented reality as a complementary tool to conventional CPR education programs [35].

In unique circumstances that hinder face-to-face training, such as a pandemic or national disaster, conventional education and evaluation of knowledge and performance using general CPR training programs can be replaced with such tools as virtual reality, augmented reality, or web-based contact platforms (Class IIb, Level C-LD). Several contactless platforms for resuscitation education (e.g., self-directed educator, high-frequency methods that apply for the resuscitation quality improvement program) are commercially available in South Korea and other countries. It could be used as a method of complementary education or retraining for HCP as well as noncontact resuscitation education for the general public [41].

Spaced learning (education or retraining separated by longer periods of time) seems to be more effective in CPR training than traditional massed instruction (education provided close together in time) (Fig. 2) [8 , 17 , 42 - 44]. BLS skills decline within 3 to 12 months after initial CPR training, but evidence suggests that more frequent retraining improves CPR skills, responders' confidence, and willingness to perform CPR (Fig. 3) (Class IIb, Level C-LD) [45].

Recently, rapid response systems (e.g., RRT or medical emergency team) have been operating in South Korea since 2020. RRT has been installed as a type of constant in-hospital monitoring system to prevent the occurrence of cardiac arrest through early intervention before risk of deterioration and cardiac arrest [6 , 46]. An early warning scoring system and an active in-hospital protocol using the alerting system should be developed alongside the activities of RRT to prevent the incidence of IHCA in adult and pediatric populations. For hospitalized adults, RRT can be effective in reducing the incidence of cardiac arrest, especially in general wards (Class IIa, Level C-LD).

To alert trained lay rescuers of events requiring CPR or PAD use, the use of mobile phone technology by emergency dispatcher systems is reasonable. Notification of lay rescuers via a smartphone app or text message is associated with shorter bystander response times. As these technologies become more ubiquitous, they are likely to play an expanding role in the chain of survival. However, it is recommended that the responders in close proximity to patients with suspected cardiac arrest are advised to ask for help by sending their global positioning system location via smartphone applications and social network systems (text messages) with prior consent (Class IIa, Level B-R).

We suggest a list of TOR rules for adult cardiac arrest patients (prehospital and emergency department settings) [47]. This aims to enable more efficient distribution and use of EMS resources available in the community, to address the issue of increased risk of HCPs and poor CPR quality during transport, and to prevent unnecessary hospital transport. Futile resuscitation could also cause a risk of infection transmission in OHCA patients with emerging infectious diseases [10]. The conventional TOR rules have been validated based on a patient registry in the U.S. and in Asia (Japan and South Korea). The KoCARC (Korean Cardiac Arrest Research Consortium) reports and various regional multicenter studies have been conducted [48 - 52]. Based on different stages, ten TOR rules have, so far, been developed that can be applied in the prehospital fields [49 , 53] or in emergency department settings [54] (Table 1) [48 - 53]. Most TOR rules comprise a stage-by-stage assessment system with consideration of not a single criterion but of multiple conditions, including unwitnessed status, asystole rhythm in the field, no prehospital shock, or ROSC is not achieved prior to arrival at the hospital.

We conditionally recommend the multimodal approach of TOR rules to assist clinicians in deciding whether to discontinue resuscitation efforts out of hospital or to transport to the emergency department with ongoing CPR (Conditional recommendation, Level C-LD). Thus, these prehospital TOR rules are considered a complementary tool in determining whether to terminate resuscitation in the field or to continue resuscitation until arrival at the hospital [50]. Notably, the sole use of the TOR rules should be avoided in deciding to terminate or postpone resuscitation. As the current Emergency Medical Service Acts and laws do not allow the decision to be made solely by paramedics in South Korea, the final decision should be confirmed by the emergency medical director.

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Greif R Bhanji F Bigham BL Education, implementation, and teams: 2020 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations *Circulation* 2020 142 16_suppl_1 S222 83 10.1161/CIR.0000000000000896 33084395 2 Morrison LJ Gent LM Lang E Part 2: evidence evaluation and management of conflicts of interest. 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care *Circulation* 2015 132 18 Suppl 2 S368 82 26472990 10.1161/CIR.0000000000000253 3 Berg KM Cheng A Panchal AR Part 7: systems of care. 2020 American Heart Association Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care *Circulation* 2020 142 16_suppl_2 S580 604 10.1161/CIR.0000000000000899 33081524 4 Cheng A Magid DJ Auerbach M Part 6: resuscitation education science. 2020 American Heart Association Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care *Circulation* 2020 142 16_suppl_2 S551 79 10.1161/CIR.0000000000000903 33081527 5 Cheng A Nadkarni VM Mancini MB Resuscitation education science: educational strategies to improve outcomes from cardiac arrest. A scientific statement from the American Heart Association *Circulation* 2018 138 e82 122 29930020 10.1161/CIR.0000000000000583 6 Avis E Grant L Reilly E Foy M Rapid response teams decreasing intubation and code blue rates outside the intensive care unit *Crit Care Nurse* 2016 36 86 90 26830185 10.4037/ccn2016288 7 Soreide E Morrison L Hillman K The formula for survival in resuscitation *Resuscitation* 2013 84 1487 93 23917078 10.1016/j.resuscitation.2013.07.020 8 Anderson R Sebaldt A Lin Y Cheng A Optimal training frequency for acquisition and retention of high-quality CPR skills: a randomized trial *Resuscitation* 2019 135 153 61 30391370 10.1016/j.resuscitation.2018.10.033 9 Nishiyama C Iwami T Murakami Y Effectiveness of simplified 15-min refresher BLS training program: a randomized controlled trial *Resuscitation* 2015 90 56 60 25724354 10.1016/j.resuscitation.2015.02.015 10 Cho JW Jung H Lee MJ Preparedness of personal protective equipment and implementation of new CPR strategies for patients with out-of-hospital cardiac arrest in the COVID-19 era *Resusc Plus* 2020 3 100015 34031648 10.1016/j.resplu.2020.100015 PMC7315986 11 Kim C Yeo IH Kim JK Confirmation of COVID-19 in out-of-hospital cardiac arrest patients and postmortem management in the emergency department during the COVID-19 outbreak *Infect Chemother* 2020 52 562 72 33263244 10.3947/ic.2020.52.4.562 PMC7779992 12 Ro YS Shin SD Song KJ Hong SO Kim YT Cho SI Bystander cardiopulmonary resuscitation training experience and self-efficacy of age and gender group: a nationwide community survey *Am J Emerg Med* 2016 34 1331 7 27037129 10.1016/j.ajem.2015.12.001 13 Yang HJ Kim GW Cho GC Tak YJ Chung SP Hwang SO Part 8. Cardiopulmonary resuscitation education: 2015 Korean Guidelines for Cardiopulmonary Resuscitation *Clin Exp Emerg Med* 2016 3 Suppl S66 8 27752648 10.15441/ceem.16.136 PMC5052914 14 Hansen SM Hansen CM Folke F Bystander defibrillation for out-of-hospital cardiac arrest in public vs residential locations *JAMA Cardiol* 2017 2 507 14 28297003 10.1001/jamacardio.2017.0008 PMC5814985 15 Pollack RA Brown SP Rea T Impact of bystander automated external defibrillator use on survival and functional outcomes in shockable observed public cardiac arrests *Circulation* 2018 137 2104 13 29483086 10.1161/CIRCULATIONAHA.117.030700 PMC5953778 16 Katipoglu B Madziala MA Evrin T How should we teach cardiopulmonary resuscitation? Randomized multi-center study *Cardiol J* 2019 9 30 10.5603/CJ.a2019.0092 PMC8169195 31565794 17 Lin Y Cheng A Grant VJ Currie GR Hecker KG Improving CPR quality with distributed practice and real-time feedback in pediatric healthcare providers: a randomized controlled trial *Resuscitation* 2018 130 6 12 29944894

10.1016/j.resuscitation.2018.06.025 18 Kim YT Shin SD Hong SO Effect of national implementation of utstein recommendation from the global resuscitation alliance on ten steps to improve outcomes from out-of-hospital cardiac arrest: a ten-year observational study in Korea *BMJ Open* 2017 7 e016925 10.1136/bmjopen-2017-016925 PMC5724141 28827263 19 Bradley SM Liu W Chan PS Duration of resuscitation efforts for in-hospital cardiac arrest by predicted outcomes: insights from Get With The Guidelines--Resuscitation *Resuscitation* 2017 113 128 34 28039064

10.1016/j.resuscitation.2016.12.017 PMC5471832 20 Virani SS Alonso A Benjamin EJ Heart disease and stroke statistics: 2020 update. A report from the American Heart Association *Circulation* 2020 141 e139 596 31992061 10.1161/CIR.0000000000000757 21 Dami F Heymann E Pasquier M Fuchs V Carron PN Hugli O Time to identify cardiac arrest and provide dispatch-assisted cardio-pulmonary resuscitation in a criteria-based dispatch system *Resuscitation* 2015 97 27 33 26433118 10.1016/j.resuscitation.2015.09.390 22 Tanaka Y Taniguchi J Wato Y Yoshida Y Inaba H The continuous quality improvement project for telephone-assisted instruction of cardiopulmonary resuscitation increased the incidence of bystander CPR and improved the outcomes of out-of-hospital cardiac arrests *Resuscitation* 2012 83 1235 41 22366353

10.1016/j.resuscitation.2012.02.013 23 Kurz MC Bobrow BJ Buckingham J Telecommunicator cardiopulmonary resuscitation: a policy statement from the American Heart Association *Circulation* 2020 141 e686 700 32088981 10.1161/CIR.0000000000000744 24 Lewis M Stubbs BA Eisenberg MS Dispatcher-assisted cardiopulmonary resuscitation: time to identify cardiac arrest and deliver chest compression instructions *Circulation* 2013 128 1522 30 23983252

10.1161/CIRCULATIONAHA.113.002627 25 Clegg GR Lyon RM James S Branigan HP Bard EG Egan GJ Dispatch-assisted CPR: where are the hold-ups during calls to emergency dispatchers? A preliminary analysis of caller-dispatcher interactions during out-of-hospital cardiac arrest using a novel call transcription technique *Resuscitation* 2014 85 49 52 24005008

10.1016/j.resuscitation.2013.08.018 26 Vaillancourt C Charette M Kasaboski A Cardiac arrest diagnostic accuracy of 9-1-1 dispatchers: a prospective multi-center study *Resuscitation* 2015 90 116 20 25766093 10.1016/j.resuscitation.2015.02.027 27 Choe MSP Lee MJ National survey of awareness and training experience of automated external defibrillator J Korean Soc Emerg Med 2019 30 301 8 28 Lee MJ Hwang SO Cha KC Cho GC Yang HJ Rho TH Influence of nationwide policy on citizens' awareness and willingness to perform bystander cardiopulmonary resuscitation *Resuscitation* 2013 84 889 94 23328406 10.1016/j.resuscitation.2013.01.009 29 Vaillancourt C Kasaboski A Charette M Barriers and facilitators to CPR training and performing CPR in an older population most likely to witness cardiac arrest: a national survey *Resuscitation* 2013 84 1747 52 23989115 10.1016/j.resuscitation.2013.08.001 30 Perkins GD Jacobs IG Nadkarni VM Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the Utstein Resuscitation Registry Templates for out-of-hospital cardiac arrest. A statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation *Circulation* 2015 132 1286 300 25391522 10.1161/CIR.0000000000000144 31 Dyson K Bray JE Smith K Bernard S Straney L Finn J Paramedic exposure to out-of-hospital cardiac arrest resuscitation is associated with patient survival *Circ Cardiovasc Qual Outcomes* 2016 9 154 60 26812932 10.1161/CIRCOUTCOMES.115.002317 32 Tuttle JE Hubble MW Paramedic out-of-hospital cardiac arrest case volume is a predictor of return of spontaneous circulation *West J Emerg Med* 2018 19 654 9 30013700 10.5811/westjem.2018.3.37051 PMC6040895 33 Weiss N Ross E Cooley C Does experience matter? Paramedic cardiac resuscitation experience effect on out-of-hospital cardiac arrest outcomes *Prehosp Emerg Care* 2018 22 332 7 29271682

10.1080/10903127.2017.1392665 34 Bonnetain E Boucheix JM Hamet M Freysz M Benefits of computer screen-based simulation in learning cardiac arrest procedures *Med Educ* 2010 44 716 22 20636591 10.1111/j.1365-2923.2010.03708.x 35 Leary M McGovern SK Chaudhary Z Patel J Abella BS Blewer AL Comparing bystander response to a sudden cardiac arrest using a virtual reality CPR training mobile app versus a standard CPR training mobile app *Resuscitation* 2019 139 167 73 31005588 10.1016/j.resuscitation.2019.04.017 36 Ringh M Fredman D Nordberg P Stark T Hollenberg J Mobile phone technology identifies and recruits trained citizens to perform CPR on out-of-hospital cardiac arrest victims prior to ambulance arrival *Resuscitation* 2011 82 1514 8

21854731 10.1016/j.resuscitation.2011.07.033 37 Berglund E Claesson A Nordberg P A smartphone application for dispatch of lay responders to out-of-hospital cardiac arrests Resuscitation 2018 126 160 5 29408717 10.1016/j.resuscitation.2018.01.039 38 Stroop R Kerner T Strickmann B Hensel M Mobile phonebased alerting of CPR-trained volunteers simultaneously with the ambulance can reduce the resuscitation-free interval and improve outcome after out-of-hospital cardiac arrest: a German, population-based cohort study Resuscitation 2020 147 57 64 31887366 10.1016/j.resuscitation.2019.12.012 39 Lehmann R Lutz T Helling-Bakki A Kummer S Huwendiek S Bosse HM Animation and interactivity facilitate acquisition of pediatric life support skills: a randomized controlled trial using virtual patients versus video instruction BMC Med Educ 2019 19 7 30611273 10.1186/s12909-018-1442-5 PMC6321687 40 Lehmann R Thiessen C Frick B Improving pediatric basic life support performance through blended learning with webbased virtual patients: randomized controlled trial J Med Internet Res 2015 17 e162 26139388 10.2196/jmir.4141 PMC4526972 41 Dudzik LR Heard DG Griffin RE Implementation of a low-dose, high-frequency cardiac resuscitation quality improvement program in a community hospital Jt Comm J Qual Patient Saf 2019 45 789 97 31630977 10.1016/j.jcjq.2019.08.010 42 Ernst KD Cline WL Dannaway DC Weekly and consecutive day neonatal intubation training: comparable on a pediatrics clerkship Acad Med 2014 89 505 10 24448036 10.1097/ACM.000000000000150 43 Patocka C Cheng A Sibbald M A randomized education trial of spaced versus massed instruction to improve acquisition and retention of paediatric resuscitation skills in emergency medical service (EMS) providers Resuscitation 2019 141 73 80 31212041 10.1016/j.resuscitation.2019.06.010 44 Sullivan NJ Duval-Arnould J Twilley M Simulation exercise to improve retention of cardiopulmonary resuscitation priorities for in-hospital cardiac arrests: a randomized controlled trial Resuscitation 2015 86 6 13 25447038 10.1016/j.resuscitation.2014.10.021 45 Bhanji F Mancini ME Sinz E Part 16: education, implementation, and teams. 2010 American Heart Association Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care Circulation 2010 122 18 Suppl 3 S920 33 20956232 10.1161/CIRCULATIONAHA.110.971135 46 Al-Qahtani S Al-Dorzi HM Tamim HM Impact of an intensivist-led multidisciplinary extended rapid response team on hospital-wide cardiopulmonary arrests and mortality Crit Care Med 2013 41 506 17 23263618 10.1097/CCM.0b013e318271440b 47 Morrison LJ Eby D Veigas PV Implementation trial of the basic life support termination of resuscitation rule: reducing the transport of futile out-of-hospital cardiac arrests Resuscitation 2014 85 486 91 24361458 10.1016/j.resuscitation.2013.12.013 48 SOS-KANTO 2012 Study Group A new rule for terminating resuscitation of out-of-hospital cardiac arrest patients in Japan: a prospective study J Emerg Med 2017 53 345 52 28843461 10.1016/j.jemermed.2017.05.025 49 Goto Y Funada A Maeda T Okada H Goto Y Field termination-of-resuscitation rule for refractory out-of-hospital cardiac arrests in Japan J Cardiol 2019 73 240 6 30580892 10.1016/j.jjcc.2018.12.002 50 Lee DE Lee MJ Ahn JY New termination-of-resuscitation models and prognostication in out-of-hospital cardiac arrest using electrocardiogram rhythms documented in the field and the emergency department J Korean Med Sci 2019 34 e134 31050224 10.3346/jkms.2019.34.e134 PMC6497980 51 Rotering VM Trepels-Kottek S Heimann K Brokmann JC Orlikowsky T Schoberer M Adult "termination-of-resuscitation" (TOR)-criteria may not be suitable for children: a retrospective analysis Scand J Trauma Resusc Emerg Med 2016 24 144 27927227 10.1186/s13049-016-0328-y PMC5142344 52 Yoon JC Kim YJ Ahn S Factors for modifying the termination of resuscitation rule in out-of-hospital cardiac arrest Am Heart J 2019 213 73 80 31129440 10.1016/j.ahj.2019.04.003 53 Guber NK Tainter CR Abramson TM Staats K Gilbert G Kim D A simple decision rule predicts futile resuscitation of outof-hospital cardiac arrest Resuscitation 2019 142 8 13 31228547 10.1016/j.resuscitation.2019.06.011 54 Morrison LJ Verbeek PR Vermeulen MJ Derivation and evaluation of a termination of resuscitation clinical prediction rule for advanced life support providers Resuscitation 2007 74 266 75 17383072 10.1016/j.resuscitation.2007.01.009 Fig. 1. Core pyramid of education and system implementation for enhanced chain of survival. CPR, cardiopulmonary resuscitation; CA, cardiac arrest; CQI, continuous quality improvement; EMS, emergency medical services; ALS, advanced life support; ICT, information and communication technology.

Example of module differences between massed instruction and spaced learning.

Scheme of booster training for small and frequent learning.

TOR, termination of resuscitation; ROSC, return of spontaneous circulation; BLS, basic life support; EMT, emergency medical technician; ALS, advanced life support; CPR, cardiopulmonary resuscitation; KoCARC, Korean Cardiac Arrest Research Consortium; CARES, Cardiac Arrest Registry to Enhance Survival; ED, emergency department; SOS-KANTO, Survey of Survivors after out-of-hospital cardiac arrest in Kanto area.