2020 Korean Guidelines for Cardiopulmonary Resuscitation. Part 2. Environment for cardiac arrest survival and the chain of survival

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ENVIRONMENT FOR CARDIAC ARREST SURVIVAL

Survival of out-of-hospital cardiac arrest (OHCA) affects medical factors related to the prevention, treatment, and rehabilitation of victims of cardiac arrest, as well as non-medical factors including public awareness of cardiac arrest, cardiopulmonary resuscitation (CPR) education, and the cardiac arrest treatment system (CATS). Once OHCA has occurred, the chance of the victim surviving is low even with effective resuscitation; thus, prevention is an important means of reducing the number of deaths due to OHCA.

The CATS is a collective body of personnel, equipment, organizations, and systems involved in the treatment of cardiac arrest. Establishing an effective CATS is essential for saving the lives of victims of cardiac arrest. However, to reduce deaths from cardiac arrest and to facilitate the effective functioning of the CATS, a medical and a non-medical environment for cardiac arrest needs to be established in the community. The environment for cardiac arrest survival refers to the surroundings necessary for the support and improvement of the medical and non-medical components needed for the prevention, treatment, and rehabilitation of victims of cardiac arrest in the community. Communities need to establish an adequate environment for cardiac arrest survival to minimize the number of deaths from cardiac arrest.

Prevention of cardiac arrest

The incidence of OHCA in Korea was 59.5 per 100,000 population in the 2018 survey, and is on the rise.[1] Since the incidence of cardiac arrest increases with age, there is a possibility that in the future, more cardiac arrests will occur in Korea where the population is aging. OHCA occurs in Koreans about 10 years earlier than the average age for OHCA in other Asian countries; therefore, the public health burden of cardiac arrest is relatively large in Korea.[2] Cardiac arrest is more likely to occur in patients with high-risk heart diseases, including coronary artery disease, heart failure, and cardiac arrhythmias. However, victims of cardiac arrest include more relatively healthy people without specific heart diseases or chronic diseases and who only have general risk factors for heart disease than those with high-risk heart disease.[3] In 2018, the survival-to-discharge rate of cardiac arrest in Korea was 8.6% and the rate of favorable neurological recovery was only 5.1%.[1] Despite efforts to resuscitate victims of cardiac arrest in communities and hospitals, only very few victims of cardiac arrest return to their normal life. Therefore, it is necessary for the national and local communities to set up strategies for managing high-risk groups for cardiac arrest in the population to prevent the occurrence of cardiac arrest among them.

Unexpected cardiac arrest occurs even in the hospital. In South Korea, there is a lack of data on the incidence and outcomes of in-hospital cardiac arrest (IHCA). According to a report from the American Heart Association Get With The Guidelines-Resuscitation registry, the incidence of IHCA is 9 to 10 per 1,000 inpatients and the survival rate is about 25%.[4] The rate of IHCA among persons with non-shockable rhythm (asystole and pulseless electrical activities) is increasing, and the rate of survival-to-discharge and neurological recovery have not improved.[5] Each hospital needs to prepare a plan for preventing cardiac arrest and treating patients who suffer from cardiac arrest. To this end, it is recommended that the hospital operates a rapid response team that can monitor a patient's symptoms or signs to detect the early warning signs of cardiac arrest and cope with patient crises.[6,7]

CPR training

Bystander CPR is one of the important factors that determine the survival of victims of OHCA. Providing CPR training to the public will improve the ability of people in the community to respond to cardiac arrest. Various campaigns or events (Kids Save Lives and World Restart a Heart by the European Resuscitation Council, American Heart Association's CPR awareness week) help to spread the awareness of cardiac arrest and the importance of CPR to the public.[8,9] CPR training requires instructors and appropriate facilities and equipment, as well as quality assessment of the training results. To disseminate CPR training, the national and local communities need a system and legislations for recruiting appropriate resources for CPR training and systematically implementing CPR education.

The survival rate of IHCA is improved when the resuscitation team includes members who have received advanced life support (ALS) training.[10] Victims of IHCA who are treated with CPR and ALS in accordance with the guidelines have a high survival rate.[11] In the 2020 guidelines, medical personnel in hospitals are advised to receive CPR training at a level suitable for their job description, and medical personnel in the CPR team are advised to complete a certified CPR and ALS training course.

CATS

The CATS is a sociomedical system utilized for the seamless resuscitation of victims of OHCA, and is used from the point of recognition of cardiac arrest to the discharge of the patient from the hospital. The system includes the emergency medical system (EMS), medical resources, policies, and medical facilities related to the treatment of cardiac arrest. Considering the current status of the CATS in Korea, the 2020 CPR guidelines recommend strengthening the following elements to increase the survival rate of victims of OHCA.

Public access defibrillation

Public access defibrillation (PAD) refers to defibrillation of a victim of cardiac arrest by a lay rescuer using an automated external defibrillator (AED) installed in a public place. The PAD program shortens the time from cardiac arrest to defibrillation by allowing defibrillation to be performed before emergency medical personnel arrive at the scene of the cardiac arrest. For victims of OHCA with shockable rhythm, defibrillation by a witness doubles the rate of neurologically favorable survival for 1 month.[12] In Korea, it is mandatory to install an AED in places where there is a high possibility of cardiac arrest occurring, such as in multi-use facilities or apartment complexes. Despite the widespread installation of AEDs, the rate of defibrillation by a witness during cardiac arrest is very low. Lay rescuers are reluctant to use an AED because of their unfamiliarity with the equipment, fear of using medical devices, and concerns about responsibility for the results of use.[13] To increase the rate of on-scene defibrillation, it is necessary to educate the public about the importance of PAD, the safety and use of AEDs, and legal protection for emergency care providers.

Role of emergency medical dispatchers

Emergency medical dispatchers play a role in initiating treatment for the victims of OHCA by connecting the EMS with witnesses of

cardiac arrest. Cellular phones are used in the rescue process by enabling real-time calls (or video calls) between witnesses and emergency medical dispatchers. In the process of treating cardiac arrest outside the hospital, emergency medical dispatchers can help the witness to recognize cardiac arrest and perform CPR through a real-time call (or video call). It is recommended that emergency medical dispatchers use a standardized protocol to shorten the time required to initiate CPR when talking to the caller.[14] In addition, if the emergency medical dispatcher instructs the caller to perform CPR with a telephone-assisted CPR system, the survival rate of OHCA can be increased.[15] The 2020 guidelines recommend that emergency medical dispatchers use a standardized cardiac arrest protocol and a telephone CPR guidance system to increase the rate of cardiac arrest recognition and bystander CPR.

Use of social media

If a witness of an OHCA informs people nearby that a cardiac arrest has occurred, one of the contacted persons can go to the scene for CPR or bring an AED to the site. As the social network service develops, it can be used in various ways to inform people around of the occurrence of cardiac arrest. The survival-to-discharge rate of victims of OHCA increases when witnesses of cardiac arrest notify neighbors of the occurrence of cardiac arrest using location information and text messaging on mobile phones.[16] In addition, if the location information of cardiac arrest is provided to volunteers who have received CPR training, the rate of bystander CPR increases.[17] As the social media technology expands, a plan that incorporates and utilizes the social media technology in the CATS should be put in place. The 2020 guidelines recommend using social media technology, including mobile phone location information and text messaging, to inform responders in the vicinity (who have agreed in advance) of the occurrence of cardiac arrest.

Cardiac arrest center

Comprehensive post-resuscitation care, including identification and treatment of underlying disease, intensive monitoring and care for post-cardiac arrest syndrome, and rehabilitation therapy are required for the persons resuscitated from cardiac arrest. Treatment of victims of cardiac arrest at a medical institution with a cardiac arrest center, which is equipped with an intensive care and targeted temperature management (TTM) unit, coronary angiography unit, and facilities to determine neurological prognoses, lowers the mortality rate of victims of cardiac arrest.[18] The survival-to-discharge rates and favorable neurological outcomes increase when victims of OHCA are transferred to a cardiac arrest center.[19] The 2020 guidelines recommend that victims of OHCA

be transferred to hospitals where intensive care and coronary angiography are available, and that the criteria for the functions and facilities of cardiac arrest centers be set.

Assessment and improvement of the quality of the CATS

Activities to improve the CATS (monitoring, assessment, and quality improvement activities) optimize and enhance the treatment process for cardiac arrest, which results in an increase in cardiac arrest survival.[20-23] To evaluate the process and the quality of cardiac arrest treatment, it is necessary to select indicators for evaluating the performance of the CATS, and then periodically monitor the indicators. The indicators for evaluating the performance of the CATS include outcome indicators that can determine treatment results such as survival rate and neurological outcomes, as well as process indicators related to cardiac arrest treatment such as CPR education status, bystander CPR rate, the rate of AED use, and the efficiency of the EMS (response time, the ability of paramedics to perform resuscitation techniques, and indicators of in-hospital resuscitation). To improve the CATS, each community is required to set goals for the CATS and develop and implement plans to achieve them. The process of evaluating and continuing to improve the CATS in the community requires labor, finance, and cooperation with relevant institutions. Hospitals should also conduct evaluation and quality control to streamline the IHCA treatment system. To improve the quality of resuscitation in the hospital, the hospital needs to monitor indicators related to the rapid response team, the employee's completion rate for CPR training, CPR performance, interventions including TTM, and resuscitation outcomes including the survival-to-discharge and neurological recovery rates. To improve the survival rate of cardiac arrest, it is recommended that communities and medical institutions set goals to improve the performance of the CATS, and to evaluate key target indicators for continuous quality assessment.

CHAIN OF SURVIVAL

The chain of survival is the link between the most important elements that must be implemented to save the life of a person experiencing cardiac arrest. When cardiac arrest occurs, the effective implementation of each component of the chain of survival increases the chances of survival for victims of cardiac arrest. Each element of the chain of survival is affected by the environment for cardiac arrest survival in the country, community, or medical institution. The environment for cardiac arrest survival strengthens the chain of survival by making each element efficient.

The first step in the chain of survival begins with a witness who recognizes the occurrence of cardiac arrest and promptly

calls for help. The second step is for a witness to perform high-quality CPR on the victim as soon as possible. The third step is to defibrillate the victim using an AED or defibrillator to treat shockable rhythm. The fourth step is to provide ALS, including defibrillation, drug administration, advanced airway management, or extracorporeal CPR. The fifth step is to correct the cause of cardiac arrest in a victim whose spontaneous circulation is restored, and to perform comprehensive post-resuscitation care including TTM and rehabilitation treatment for survivors. In the 2020 guidelines, the chain of survival for OHCA and for IHCA are presented separately (Fig. 1).

Recognition of cardiac arrest and activation of the EMS (for OHCA) or the resuscitation team (for IHCA)

Common clinical signs of cardiac arrest include loss of consciousness, apnea, and pulselessness; however, agonal gasping or convulsions may occur immediately after cardiac arrest.[24,25] When a witness promptly recognizes the occurrence of cardiac arrest and requests for a rescue team, treatment for cardiac arrest should begin immediately to improve the chances of survival.[26] Therefore, the curriculum for CPR training should include information on the recognition of cardiac arrest and its clinical symptoms. Emergency medical dispatchers should be educated on how to determine whether a victim is in cardiac arrest through an emergency call, and how to use standardized algorithms and criteria to determine if cardiac arrest has occurred. Regarding the improvement of IHCA survival, hospitals are advised to operate a rapid response team (or medical emergency team) that can prevent and respond to the occurrence of cardiac arrest in the hos-

pital, using the indicators of early warning signs that appear before cardiac arrest occurs.[26,27]

The request for help is the first action that a witness should take after recognizing that a cardiac arrest has occurred. Outside the hospital, the EMS is activated by a witness that requests for help from a nearby person and calls 119. In the hospital, the request for help is done by asking for help from nearby medical personnel and calling for the resuscitation team.

CPR

During the process of rescuing a victim of OHCA, witnesses should begin CPR immediately after requesting for help and activating the EMS. The survival rate of patients with OHCA is approximately four times higher with bystander CPR than without bystander CPR.[28] The survival rates of victims of OHCA who underwent chest compression-only CPR and those who underwent standard CPR including rescue breathing are not different.[29] Therefore, it is recommended that those who witness cardiac arrest should begin CPR immediately, and those who are not willing to do artificial ventilation should perform chest compression-only CPR. Employees who recognize a cardiac arrest in the hospital should immediately provide basic life support. Hospital staff should receive regular CPR training and provide high-quality CPR to victims of cardiac arrest.

Defibrillation

Every one-minute delay in defibrillation after ventricular fibrillation occurs reduces the likelihood of successful defibrillation by 7% to 10%.[30,31] The PAD program should be disseminated and
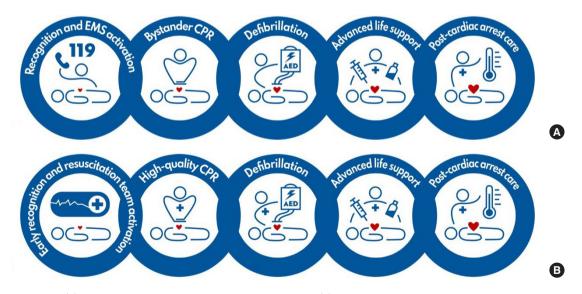

Fig. 1. Chain of survival. (A) Chain of survival for out-of-hospital cardiac arrest. (B) Chain of survival for in-hospital cardiac arrest. EMS, emergency medical system; CPR, cardiopulmonary resuscitation; AED, automated external defibrillator.

activated for rapid defibrillation in an environment outside the hospital; this contributes to the increased survival of victims of OHCA.[12] In addition to installing an AED for a PAD program, a plan to enhance the use of the automatic defibrillator should be put in place. In hospitals, it is vital to install an AED in a place where rapid defibrillation is necessary and to train staff to use an AED when cardiac arrest occurs.

ALS

For a victim whose spontaneous circulation is not restored even with basic resuscitation including CPR and defibrillation, advanced measures including drug administration, advanced airway management, advanced monitoring, or extracorporeal CPR, are required. During the treatment of OHCA, emergency medical technicians (EMTs) may secure the airway using advanced airway management or administer drugs including epinephrine. There is some controversy over whether provision of ALS at the scene improves the survival rate of victims of OHCA.[32,33] Therefore, it is recommended that EMTs follow the medical guidance of the supervising doctor when they perform ALS in the field and decide to transfer the patient to the hospital. During IHCA treatment, the resuscitation team should consider the use of point-of-care ultrasound when available, routine defibrillation and drug administration, and the implementation of advanced resuscitation measures including extracorporeal CPR. Since advanced resuscitation measures including extracorporeal CPR are not performed frequently, resuscitation teams should be trained on how to quickly perform these procedures.

Post-resuscitation care

All victims of cardiac arrest whose spontaneous circulations are restored need to be admitted into an intensive care facility to receive post-resuscitation treatment, including intensive monitoring and treatment for post-cardiac arrest syndrome. Cardiac arrest survivors need rehabilitation treatment to return to their daily lives. Treatment of victims of OHCA in a cardiac arrest center, which has an intensive care unit, a facility for TTM and 24-hour coronary angiography, and relevant personnel for providing effective resuscitation treatment, is associated with improved survival.[19,34] Patients resuscitated from cardiac arrest should receive rehabilitation treatment according to a plan established based on the results of the systematic evaluation of neurological damage including cognitive impairment.[35] The 2020 guidelines recommend that patients resuscitated from cardiac arrest need to be transferred to a medical institution that has adequate facilities, personnel, and equipment for effective post-resuscitation care and rehabilitation treatment for neurological sequelae.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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