

Perspectives

Optimization of the Pre-Hospital Rescue System for Out-of-Hospital Cardiac Arrest in China

Lei Hou^{1*}; Yumeng Wang^{1,2}; Wenlei Wang³

ABSTRACT

Out-of-hospital cardiac arrest (OHCA) presents a significant public health challenge in China. A sharp contrast in survival rate after OHCA exists between China and more developed countries. Due to the short life-saving time window, emergency medical services (EMS) and bystanders peripheral to EMS are key contributors to survival after OHCA. Here we discuss limitations and challenges for current EMS in rescuing OHCA by reviewing requirements for EMS in China. We call for an updated public health-based pre-hospital rescue system that includes establishing a cardiac arrest registry, promoting a “Three Early’s” campaign [early dialing of emergency hotline 120, early cardiopulmonary resuscitation (CPR), and early defibrillation], and operating a mechanism comprised of professional public health institutions (EMS, CDC, specialized disease prevention and control institutions, and health education institutions) as well as many governmental departments, such as healthcare, industry and information technology, and education, and non-governmental organizations, such as the Red Cross Society. Following the optimization of the pre-hospital rescue system and the participation of the whole population in self-rescue and mutual rescue, we believe that a dramatic improvement in OHCA survival will come about in China.

Out-of-hospital cardiac arrest (OHCA), defined as the absence of signs of circulation irrespective of whether the assessment was made by emergency medical services (EMS) or bystanders (1), presents a significant public health challenge in China (2). OHCA — the most serious pre-hospital conditions — have various causes, both cardiac and non-cardiac (such as trauma) and often occur in the general population (3). Bystanders could see or hear cardiac arrest occurrence in 60%–80% of OHCA cases

(4); however, the vast majority of OHCA patients already died by the time EMS arrived because of a general delay in the initiation of CPR after cardiac arrest. Note that 78.5% of all-cause deaths and about 70% of deaths from coronary heart disease — one of the important causes of OHCA — occur out of hospital, according to the China Information System of Death Register and the World Health Organization (WHO) MONICA Project (monitoring of trends and determinants in cardiovascular disease). A sharp contrast in survival rate after OHCA exists between some areas of China (1.6%) and the United States (26.1%) (5–6). The Global Resuscitation Alliance believes that the survival rate can increase by 50% — based on current <1%–26.1% worldwide — with adherence to and implementing of best community-based practices (6).

REQUIREMENTS FOR EMS IN HEALTHY CHINA 2019–2030

Improving pre-hospital rescue system has been a component of the *Campaign of Cardiovascular and Cerebrovascular Disease Prevention and Treatment of the Healthy China Initiative (2019–2030)*. In 2020, nine governmental sectors, including the National Health Commission and National Development and Reform Commission, issued further guidance to promote pre-hospital EMS. The key contents and targets are shown in Table 1; in summary, the 2020 national guidance is the complement and perfection of the *Healthy China Initiative (2019–2030)*, which suggests current insufficiency in developing EMS.

Challenges for Pre-hospital Rescue System in Rescuing OHCA

EMS is a system closely linked to hospitals and healthcare centers; however, few patients suffering

TABLE 1. Key contents and targets of the pre-hospital rescue system in healthy China.

Category	Key contents of the <i>Healthy China Initiative (2019–2030)</i>	The 2025 targets of the 2020 national guidance issued by nine governmental sectors
EMS planning	Chest pain center established in each prefecture, city, and county; hospital-based stroke center developed; the “Green” channel developed to connect the pre-hospital and in-hospital treatment of chest pain and stroke	EMS center or station established in each prefecture-level city and conditional county; EMS radius achieved: ≤ 5 km in urban areas and 10–20 km in rural areas; EMS center as information platform of unified command and dispatch sharing healthcare information in each prefecture-level city; EMS network improved to include one EMS center and multiple hospitals or healthcare centers in urban and rural areas
Pre-hospital equipment and facilities	Emergency map for chest pain and stroke developed; AEDs provided in crowded places; One ambulance for every 50,000 people	Provision of one ambulance for every 30,000 people in prefecture-level cities (the allocation level of each county can refer to prefecture-level cities, and its base population can be increased to 300% of the county population)
EMS response	100% of 10-second EMS answering rate achieved; 5-minute departure rate of ambulances increased	The 120 emergency hotline being operated nationwide; 95% of calls being answered within 10 seconds and 3-minute departure rate of ambulances; 100% of patients with pre-hospital medical record; 98% of on-scene care rate for critical patients
EMS personnel	Personnel training strengthened and ability of disease prevention and emergency response improved	Sufficient healthcare staff guaranteed in each independent EMS center (station)

Abbreviations: EMS=emergency medical services; AED=automatic external defibrillator.

OHCA survive long enough to be admitted to a hospital. Moreover, telephone CPR (T-CPR) guidance for bystanders and advanced life support (ALS) provided by EMS remain an inaccessible link to survival for OHCA patients. T-CPR can significantly increase the rate of bystander CPR implementation and deliver greater chances of survival until ALS arrives. However, current policies on developing EMS lack the requirement of T-CPR from “120” dispatchers of the EMS, resulting in no formal pre-arrival telephone instructions given in urban Beijing (5). This likely contributes to the low rate of bystander CPR, which could be related to poor OHCA survival.

The survival chances of OHCA patients usually decrease dramatically as time lengthens from collapse to first CPR and is close to zero within 10 minutes. Evidence shows that the rate of discharge from hospital of live patients after EMS-witnessed OHCA from cardiac causes is 10.5%, significantly higher than 0.4% for OHCA not witnessed by EMS or bystanders (7). However, average EMS response time (call receipt to scene) is nine minutes in the United States compared to more than 15 minutes in China (8–9). It is difficult to reduce the average EMS response time to the ideal level, although evidence shows that this method is likely to be a fast and effective way of increasing OHCA survival (10). For example, this time remained 15 minutes over the period 2013–2017 in Beijing (5); in western China, the trend first decreased from 31.959 minutes during 1996–2000 to 13.712 minutes during 2005–2010 but increased again to 17.665 minutes during 2011–2015 (9).

PERSPECTIVE OF PUBLIC HEALTH EMERGENCY RESCUE SYSTEM FOR OHCA

Establishment of a Resuscitation Registry

Clear definitions and continuous measurement of performance indicators enable a collective approach to improving measures to increase the survival rate of OHCA patients. The Utstein Resuscitation Registry has been employed since 1990 for this purpose. Many countries, such as the United States and Japan, have established a nationwide or regional OHCA registration system by using the Utstein method. In China, this registry has been in operation since 2012 but only in a few cities, such as Beijing and Hangzhou, and only limited surveys of the Utstein style have been conducted, so continuing improvement in survival must start from a relatively poor basic level. Recently, the China CDC launched a pilot citywide cardiac arrest registry to enhance survival, accompanied by EMS-based T-CPR and community-based CPR training, in Xiangtan City, Hunan Province.

Initiation of the “Three Early’s” Campaign for OHCA Rescue

By calling the 120 emergency hotline early, early CPR, and early defibrillation (the “Three Early’s”) are important for increasing the chance of survival. After OHCA, prompt administration of basic life support

(BLS), including early bystander CPR, early public-access defibrillation, and a call as early as possible to the 120 hotline for guidance, combined with later ALS from the professional EMS, are key factors in a successful rescue. However, the “Three Early’s” campaign, particularly early CPR and early defibrillation, has not been endorsed by the EMS and depends on the health-support environment provided by the government.

In China, the rate of bystander CPR is as low as 2.8%–11.4%. There are several ways to increase this rate. First, the improvement of national health literacy is required. The *Healthy China Initiative* has required that at least 3% of all residents to be trained with first aid certificates by 2030. Of university students who should have usually been more keen on public welfare undertakings, only 45.5% were willing to participate in CPR training (11). Recently, the Ministry of Education asked CPR to enter primary and secondary school classes, which has taken a big step in promoting and popularising CPR. Obstacles to CPR implementation also exist among trained people, such as lack of confidence, fear of secondary damage to patients, and legal liabilities. A survey reported that 13.7% of respondents would prosecute for liability when bystander CPR failed for family members with OHCA (12). Overall, people generally lack a proper understanding of OHCA and CPR. Second, public CPR training should be well organized. CPR should be designed as a mandatory course in school and pre-job training for occupations such as policing, firefighting, security, stewarding, and teaching. Public CPR training should be acknowledged as one of the important functions of professional public health institutions, including CDCs and health education institutions besides EMS centers. Third, as mentioned above, 120 hotline dispatchers, when answering an emergency call, should encourage and guide bystanders to implement CPR following identification of a suspected OHCA. Fourth, it is important that legal support is provided for professionals out of EMS and non-professionals participating in OHCA rescue. When the rescue fails, the rights and interests of rescuers should be guaranteed. For example, just released *Law for Medical Practitioners* has added an article on encouraging participation in out-of-hospital rescue from medical practitioners with failure exemption, as similar as we have suggested before (2). Nonetheless, it is promising for increasing cases with bystander CPR to make more OHCA seen, heard, or monitored by using potential advanced technology,

such as wearable devices to detect “early-warning” signals linked with EMS network.

The number of automatic external defibrillators (AEDs) in urban areas of China is inadequate, with almost no AEDs in most rural counties; this results in few reported cases with public-access defibrillation. To increase the access to an AED for OHCA, several approaches should be considered. First, more AED equipment must be placed in key locations where there is a greater chance of OHCA events. Second, an AED network should be built to enable the public to know the location of AEDs and connect with EMS easily. Third, the operation and maintenance of AEDs and a sufficient population with CPR training are essential.

EMS Inclusion in the Public Health System

The essence of rescuing OHCA lies in establishing and operating a public health mechanism for initiating BLS from bystanders as early as possible, thereby gaining the time window until the follow-up ALS from EMS. Links in the survival chain are related to multiple functions of different departments. For example, a 120 hotline dispatch center with emergency stations is currently under control of hospital management departments, while CPR training and AED rollout are associated with many departments such as healthcare, emergency, industry and information technology, education, transportation, housing and urban-rural development, public security, and justice. Moreover, capital investment and personnel need support from local finance and human resources departments. Therefore, the government should take responsibility for coordination and organization. The *Primary Health Care, Medicine and Health Promotion Law* has defined an emergency center (station) as one of the professional public health institutions. Alongside the EMS, other professional public health institutions, such as CDC, specialized disease prevention and control institutions, and health education institutions, should participate in this work. Enhancing survival from OHCA is a common responsibility of these government-established institutions, non-governmental organizations, such as the Red Cross Society, and the aforementioned departments.

CONCLUSIONS

Pre-hospital rescue of OHCA is the main battlefield

of cardiovascular disease treatment. Bystanders have only a short time window to save OHCA victims before the EMS arrive. Optimizing EMS and enhancing the public health system by improving bystander participation represent the current best approach to increase OHCA survival.

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Corresponding author: Lei Hou, houlei@ncncd.chinacdc.cn.

¹ National Center for Chronic and Noncommunicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing, China; ² Public Health School, Baotou Medical College, Baotou, Inner Mongolia Autonomous Region, China; ³ The Center for Disease Control and Prevention of Xinjiang Uygur Autonomous Region, Urumqi, Xinjiang Uygur Autonomous Region, China.

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