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International Emergency Medicine

PREHOSPITAL EMERGENCY CARE IN SHANGHAI: PRESENT AND FUTURE

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Abstract—Background: In Shanghai, prehospital emergency medical services are provided by the public Ambulance Services. The 60th anniversary of the local Ambulance Services is a good opportunity to provide an overview of the current trends in prehospital emergency medical care in Shanghai. **Objectives:** In this report, the features of Shanghai prehospital emergency medical care are described, as well as the Shanghai model of purely prehospital emergency medical care, including the communications and dispatch system, ambulance depots and ambulances, and prehospital rescue teams. Responses to major incidents including public health emergencies and natural disasters are also discussed, with the intention of highlighting future directions in emergency medical services, as well as the influence of international trends in emergency patient care. **Discussion:** Although Shanghai has the most advanced dispatch system in China (equipped with a Global Positioning System, Global Information System, and more) and can be expanded quickly in case of mass casualty incidents, there is, as yet, no uniform Emergency Medical Service (EMS) dispatching for the entire city. Nor are there certifications, degrees, or special continuing education programs available for EMS dispatchers. Although there are more and more ambulance depots spread all over Shanghai, the city struggles with inadequate prehospital emergency caregivers, because every ambulance has to be staffed with a qualified Emergency Physician, and there are also recruitment problems for ambulance physicians. **Conclusions:** Although faced with many challenges, substantial progress is expected in Shanghai prehospital emergency care. © 2012 Elsevier Inc.

Keywords—Emergency Medical Service (EMS); prehospital care; Emergency Medicine; five-year guideline; Shanghai; China

INTRODUCTION

The People's Republic of China is a country of 1.3 billion people, and is one of the most densely populated countries in the world (1). Since the late 1970s it has undergone considerable changes, since reforms known as the Four Modernizations improved agriculture, industry, technology, and defense, vastly raising living standards and making China one of the great powers. As a global city, Shanghai exerts influence over commerce, finance, culture, art, fashion, research, and entertainment. The city is located in the middle portion of the Chinese coast, and sits at the mouth of the Yangtze River (2). It is administratively a municipality that is equal to a province, is an autonomous region, and is divided into 18 county-level divisions, including 17 districts and one county (Figure 1). There is no single downtown district in Shanghai. The urban core is scattered across nine districts that are collectively referred to as Shanghai Proper or the city center, and these account for three-fourths of the entire city.

Demand for emergency medical care is increasing in Shanghai, along with the major epidemiological transition. It is one of the most populous cities in P.R. China, with a land area of 6340 km². The permanent population



Figure 1. Shanghai is divided into 18 regions.

is currently slightly over 19 million, whereas the migrant population is about 6 million. Females account for about 50.1% of the entire population, slightly outnumbering males. The ratio of urban-to-rural population has been increasing for several years. The birth rate is one of the lowest in China, with 6.62 per 1000 persons (the rate for China overall is 12.13 per 1000 persons) and the mortality rate is 7.64 per 1000 persons. The average life expectancy at birth is 81.73 years (79.42 years for males and 84.06 years for females). Only 10.4% of the population is aged younger than 18 years, with 24.1%, 43.0%, and 22.5% being 18–34 years, 35–59 years, and at least 60 years old, respectively. The growing elderly population has resulted in an increased need for proper emergency care. In 2009, there were 2.7 doctors per 1000 persons and 4.1 hospital beds per 1000 persons. Emergency medical services provided to persons aged older than 60 years made up 61.6% of the whole service, whereas 4.4%, 12.7%, and 21.3% of the service was provided to those aged younger than 18 years, 18–34 years, and 35–59 years, respectively.

According to data from the Shanghai Emergency Medical Center (SEMC), there were 585,298 cases of prehospital care in the city center during 2003–2007 (3). The top three most frequent diseases responded to by ambulance services were injury, cerebrovascular disease, and cardiovascular disease, accounting for

36.7%, 23.5%, and 15.4%, respectively; this was dramatically higher than the comparable data from previous years (1991–1995) (4). Being the top single disease, Shanghai's total road injury cases numbered 38,472 from 2003 to 2007, with the ratio being 4.51% in 2003 but increasing to 8.32% in 2007 (3). Possible reasons for the increase are urbanization, crowding, and traffic congestion brought about by the significant economic and societal changes in Shanghai. Conversely, the percentage of tumor emergencies, acute upper gastrointestinal bleeding, and obstetrics/gynecology emergencies decreased significantly from 4.6%, 3.4%, and 3.4%, respectively, to 3.3%, 1.9%, and 2.1%, respectively (4).

DISCUSSION

The Shanghai Model of Prehospital Emergency Medical Care

Administrative system of Shanghai prehospital emergency care. With the vast territory of China and the significant locoregional differences in economic power, city size, history, and development of emergency service and catchment areas, there are five principal models of prehospital emergency service that exist across different areas. They are: purely prehospital care, independent emergency service center, prehospital care supported by general hospital, unified communication command center, and integrated within fire and police departments (5). For many years, Shanghai has employed the purely prehospital care model, comprising mainly a prehospital emergency service with no sickbeds, known as the Shanghai model, which is similar to emergency medical services in Germany. Many major Chinese cities, including Tianjin, Nanjing, Wuhan, and Hangzhou, also use this model. Beijing, formerly in the model of independent emergency service centers, also has been using the Shanghai model since 2005, mainly due to the rapid development and internationalization of the city (6). This means that an independent prehospital center with its own inpatient department cannot completely meet the needs of the citizens. Although much progress has been achieved over the last 5 years, during which the 11th 5-year guideline (a scheduled plan announced by the Shanghai government every 5 years which sets the 5 years' developing goal for Shanghai) has been applied, Emergency Medicine and prehospital emergency medical care in Shanghai are still in the "developing" phase.

In terms of administration, Shanghai prehospital medical service is operated by the public health department of the local government, the Shanghai Health Bureau. Private prehospital medical care is not yet allowed in Shanghai. The Emergency Medical Service System (EMSS) in Shanghai is divided into 10 Emergency Medical Service (EMS) areas, including Shanghai EMS (SEMC), which is

located in the city center, and nine suburban district (county)-level emergency centers. These 10 centers work independently, and generally, SEMC can give advice for emergency care only to the nine suburban district (county)-level emergency centers. SEMC serves the nine districts in the city center, whereas the nine district (county)-level emergency centers in the suburbs are responsible for prehospital care of their own district or county. However, the prehospital EMS will be organized by SEMC once disasters or public health emergencies occur. Figure 2 shows the organizational diagram of SEMC.

The emergency centers work with hospitals by emergency green channel (a term used in the area of emergency medicine to speed the initiation of the care of severely-ill patients) to establish an emergency chain between pre- and in-hospital care. The key point of the Shanghai EMSS is to provide high-quality prehospital service to its citizens, including first aid at the scene, monitoring the patient during transportation, and safe transport. The service's tasks, in addition to the rapid and safe transportation of the patient to a hospital, include the restoration and maintenance of the patient's vital functions, as well as the alleviation of pain and suffering, stabilization, and the prevention of reinjury at the scene and during transportation.

Current status of Shanghai prehospital emergency medical care. Prehospital emergency medical care in Shanghai consists of the essential components of an integrated emergency medical care system, including dispatch centers and communication system, rescue teams, ambulances, ambulance depots, and helicopter EMS. From the establishment of new China in 1949 to the end of the 11th 5-year construction, Shanghai experienced vast change in the system. Through 60 years' practice and development, a unique operational prehospital care model has been formed with the characteristics of unity of command, district-level dispatch system, distributed ambulance depots, on-the-spot medical aid, and fast transport. Whereas few ambulance or emergency telephones could be found in 1949, Ambulance Command has evolved into a modern prehospital service provider with a well-decorated urban ambulance dispatch center equipped with Global Posi-

tioning System, Global Information System, wireless communication system, and other advanced command system elements that can be expanded quickly in case of mass casualty incidents. It includes more than 500 ambulances and over 111 ambulance depots. However, prehospital emergency medical care in Shanghai is currently provided by only about 800 prehospital emergency caregivers, 219 of whom are Emergency Physicians. These numbers are substantially lower than the targets set for medical staff by the Shanghai 11th 5-year guideline for EMSS (Table 1). Because an Emergency Physician must accompany each ambulance run, this means the maximum of the ambulances that can be dispatched to provide prehospital emergency care is 219, even though there are more than 500 ambulances in the city.

Communications and dispatch system. The dispatch unit is one of the most important components of Shanghai prehospital emergency medical care. All of the dispatch units in the city center or suburban areas can be accessed by dialing the unique emergency telephone number, 120, on a telephone. Most of the dispatchers are trained as physicians, nurses, or other health care professionals. They have to undergo additional ambulance dispatch training before being allowed to take emergency calls in the centers. However, because no certification, degree, or special continuing education programs are offered for prehospital emergency medical care, most of the training courses are informal and the apprentice model is generally used to train the EMS dispatchers. Unfortunately, this makes the dispatch process non-standard and may even bring potential harm to patient care. The main duties of the dispatchers are receiving emergency calls, assessment of the received information, and dispatch of an emergency service team to the scene. The dispatchers also cooperate with the police, fire department, and other relevant services, and give telephone medical advice to callers. According to the incomplete data from SEMC, in 2009 the dispatchers received 6000–8000 ambulance calls per day, and the peak flow of ambulance dispatch by SEMC was 927 per day.

Average ambulance response time varies from one location to another (Table 2). The urban radius of service

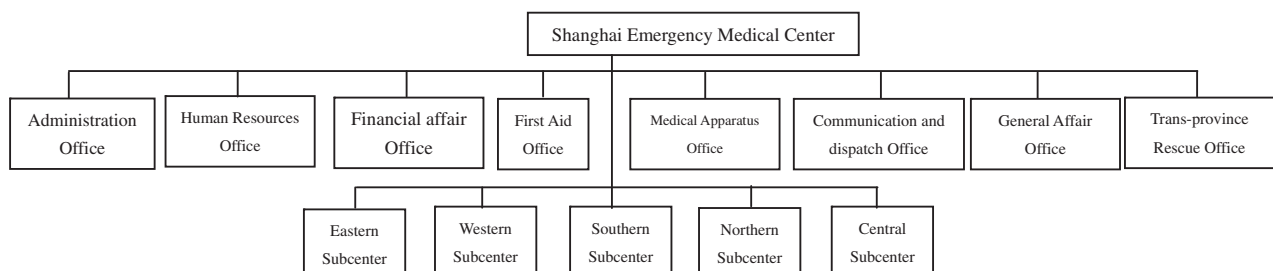


Figure 2. Shanghai Emergency Medical Center (SEMC) organizational diagram.

Table 1. Shanghai 11th 5-year Guideline for EMSS

| Items | Criteria | Targets |
|--------------------|---|---------|
| Ambulances | One ambulance for every 40,000 population | 500 |
| Ambulance stations | A basic prehospital emergency medical service network should be established | 110 |
| Medical staff | 6 staff members for one ambulance | 3000 |

EMSS = Emergency Medical Service System.
Data are provided by the Shanghai Emergency Medical Center, from the years 2006–2010.

was decreased to 3 km in 2000. The target response time, from receipt of the call to the arrival of the emergency ambulance services, is 15 min, and it is higher in rural areas. With a network of ambulances and the new urban service radius, the average response interval in the city center can be expected to be reduced to 10 min. The reasons for the long response time at the present time are complex, and include: too few available ambulances and too few ambulance depots, traffic congestion, helicopter unavailability (only one helicopter station in the whole city), and so on.

At present, there are seven dispatch units in Shanghai. Emergency calls are transferred, depending on the location where the emergency occurs or the type of call. All of the requests from mobile phones and those from landlines in the city center and new districts MinHang, BaoShan, and PuDong are connected to the dispatch center of SEMC, whereas others are connected or transferred to suburban centers. Direct lines and hospital-on-the-net allow the dispatch units to contact the ambulance depots. Wireless communications between dispatch units and ambulances also play an important role. Currently, emergency telephone calls to 110 or 119 are handled by the police or the fire department, and the direct lines between the police and fire brigade to the dispatch units allow the calls to be responded to as quickly as possible. Considering the potential delay from calling to dispatch, most of the dispatch units are now considering integrating with the fire brigade and the police.

Ambulance depots and ambulances. With the exponential increase in population size, the need for a larger and better ambulance service has also grown. There are more and more ambulance depots spread out all over Shanghai,

Table 2. Ambulance Response Times in Shanghai (2010)

| Items | Average Response Times (Min) | Service Radius (km) |
|---------------|------------------------------|---------------------|
| Urban area | 12 | 3 |
| Suburban area | 15 | 5 |

especially in densely populated residential and industrial areas, that provide emergency services 24 h a day. The number of ambulance depots in 2008 and 2009 in the entire city reached 102 and 110, respectively, meaning there is one depot serving two to three towns or sub-districts, each of which has a population of 80,000–100,000 people. The ambulances are fully equipped and staffed at the physician ambulance service level. Some ambulances are used to provide trans-province emergency care services and most of them have transportation times just short of 24 h (7).

In rare cases, Shanghai police helicopters have helped transport patients (8). There is currently only one helicopter station that works closely with Ambulance Command. The helicopter stations are administratively separate and have developed independently. Once a police helicopter is deployed, the Emergency Physicians will provide emergency care to the patient using onboard medical equipment such as a first aid kit, defibrillator, oxygen apparatus, and electrocardiographic monitor. If a patient requires special treatment on site and referral to a specialized department, the nearest hospital may be bypassed.

There is also one mobile casualty treatment center (MCTC) stationed in Shanghai. When there is a major incident involving a large number of patients that requires more ambulances, the MCTC is dispatched. The MCTC, which is supplied with more sophisticated equipment in larger quantities than a standard ambulance, has played an important role in response to major incidents. One such incident was the Shanghai 11.15 major fire disaster of November 15, 2010, when MCTC provided advanced life support to the victims with the help of medical equipment such as a ventilator, advanced airway, transcutaneous cardiac pacemaker, and glucometer. A standard ambulance is usually fitted with a communication system such as a two-way radio, and medical supplies and equipment such as a defibrillator/monitor, syringe driver, suction machine, medications, infusions, intubation equipment, immobilization equipment, stretcher, emergency suitcase, and backpack.

Prehospital rescue teams. As in the German system, instead of paramedics, there are Emergency Physicians working in Shanghai's ambulances, who typically graduate from medical school after 5 years' education. Besides the general medical education requirement, no other special qualifications are required to be an Emergency Physician. Every ambulance must be staffed with an Emergency Physician who can provide all necessary interventions on site or during transport. Because Emergency Physicians were part of the Shanghai EMS system from its very beginning, it was thought that there was no need for non-physicians working in the ambulances to learn to perform interventions that legally only

physicians are allowed to do, and there was no need for them to receive formal training. Therefore, no staff member other than the Emergency Physician is formally authorized to give medications, establish intravenous access, defibrillate, or perform tracheal intubation. For these reasons, there is a large shortage of Emergency Physicians. To meet the high demands of EMS in Shanghai, the staff in the ambulance generally works 24-h shifts, and the number of shifts per month varies.

Besides the current shortage of Emergency Physicians, there are also problems recruiting applicants for the ambulance physician program each year due to unfavorable working conditions, too large of a workload, and too low a salary. These factors attract few graduates from the medical schools. The city struggles with an inadequate number of Emergency Physicians. Currently, most of the Emergency Physicians working in ambulances are inexperienced and have received an inadequate education in Emergency Medicine. These jobs are frequently considered temporary. As a result, the number of Emergency Physicians has been decreasing, far from enough to staff all of the ambulances in Shanghai.

Major Incident Response in Shanghai

For the management of major incidents with mass casualties, every organization of Shanghai EMSS is required to have a guideline or protocol for EMS response. Prehospital care in special circumstances (e.g., public health emergencies and environmental catastrophes) is generally done in coordination with the Crisis Headquarters of the Health Bureau and Social Affairs.

Prehospital care and public health emergencies. The outbreaks of severe acute respiratory syndrome (SARS) and H1N1 flu certainly had an impact on Shanghai EMSS. Before 2003, when SARS afflicted the entire country of China, including Shanghai, there was no policy in place to guide EMSS to effectively respond to that or any other public health emergencies. However, when another public health emergency, avian influenza, hit Shanghai in 2006, changes in policy were implemented rapidly and information was disseminated effectively to all personnel. In March and April of 2009, when an outbreak of a new strain of influenza commonly referred to as "swine flu" infected many people in the world, all prehospital emergency care personnel in Shanghai were put on high alert. Universal precautions were re-emphasized, and body temperature was monitored in both patients and staff.

Prehospital response to disaster. Disaster can lead to mass casualty incidents (MCI). Examples of MCI in the past in China include the Wenchuan earthquake, landslides, flooding, and major fire incidents. Shanghai prehospital

emergency care personnel worked with others in China to respond to these MCI. During the massive Wenchuan earthquake on May 12, 2008, in which 69,197 were confirmed dead, 374,176 were injured, and 18,222 were listed as missing, Shanghai was unaffected but responded quickly by deploying six rescue teams to Sichuan Province 2 days after the earthquake (9). In their 3–6 months of operation, the field hospitals established by Shanghai teams treated more than 10,000 patients. With more victims rescued out of the ruins, some patients severely injured in the earthquake were transferred to Shanghai to receive intensive care.

On November 15, 2010, a high-rise apartment building in Shanghai caught fire. Shortly after the disaster, SEMC sent all of their nearby ambulances to the scene. The medical director of SEMC arrived there quickly and took responsibility for supervision, resource planning, and quality management of the disaster response. The director also coordinated the activities of the EMS with other institutions (e.g., police, fire brigade, hospitals). Nine hospitals in Shanghai established a Green Channel to treat people injured in the fire. The government also established an expert panel to direct the rescue efforts.

CONCLUSION

Being an immature system in Shanghai, the emergency medical system is still under development, as the specialty of Emergency Medicine in China is now receiving considerable attention from the public and government. In the coming 5 years, the 12th 5-year guideline will be implemented and substantial progress is expected in Shanghai prehospital emergency care. During this advancing progress, more emphasis should be placed on full implementation of more evidence-based advanced prehospital interventions, as well as on area-wide emergency care including both metropolitan and rural settings. To provide an optimal level of emergency care, there is a need to increase the number of qualified emergency personnel, especially Emergency Physicians, and implement medical control and oversight for the EMSS. Furthermore, efforts are needed to improve the efficiency and quality of the EMS system, such as public education, improving patient outcomes, increasing patient satisfaction, and development of disaster preparedness.

Recommendations for the Future

- A uniform and integrated dispatch system should be developed and used in the entire city of Shanghai to facilitate the dispatch of ambulances and to shorten

the average ambulance response time. Formal emergency medical dispatcher training courses also should be implemented for dispatchers.

- Although physician-staffed ambulances will continue to play a role in the EMS, a potential solution to the problem of ambulance staff shortage is to staff some ambulances with emergency medical technicians (EMTs) and paramedics. It may be a choice to organize different types of rescue teams similar to those in other countries such as Germany and France (10,11). The EMT/paramedic-based models of prehospital care, as used in the United States, also should be considered (12). Non-urgent patient transport (where staff includes only the driver or a technician and a driver) could be separated from EMS.
- There is a need to improve coordination with other services within and between hospitals, as well as with prehospital services. Enhanced coordination would have a variety of benefits for all concerned, including better EMS relationships, better hand-over, better transfers, and enhanced EMS personnel skills.
- It is essential to develop major incident and disaster plans and to promote organization for major emergencies in the various settings. Special training courses and frequent drill exercises are also needed to improve the EMS capability of coping with disaster.

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