

Emergency medicine: past, present, and future challenges

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Origin and history of emergency medicine

The term “emergency,” first used in the 1630s, is derived from the Latin word *emergere*, meaning unforeseen events that require immediate attention. The term “emergency medicine” can be traced to the French Revolution (1789–1799). In 1792, Dominique Jean Larrey, a military medical surgeon, gained a position in the Army of the Rhine and left for Strasbourg, where he witnessed great mobility of the horse artillery and then suggested that General Adam Philippe de Custine have the medical staff use this method to speed up transport of the wounded. The general approved Larrey’s proposal. Larrey’s “ambulance” was a simple carriage, despite the exposure to enemy fire. In 1797, during the first Italian campaign, Larrey created a complete rescue system with an active medical team in the battlefield. In contrast to previous rescue methods, Larrey transported critically wounded patients to the rescue station and operated on them as soon as possible, instead of delaying the operation after the battle. The timely rescue

system created by him enabled every wounded soldier to be treated within 24 hours, which significantly reduced the mortality rate. Therefore, Larrey has often been referred to as “the father of emergency medical services.”^[1]

Medicine, as a professional field, dates back to the early 19th century, while emergency medicine can only be traced back to 50 years ago, making it the most recently developed major field in medicine. Before the 1960s, staff in hospital emergency departments usually worked in rotation with family doctors, general surgeons, physicians, and other specialists. In many small emergency departments, nurses conducted the triage of patients, and specialty doctors were called in based on the type of injury or disease. Many pioneers of emergency medicine were family doctors and other specialists, who believed that extra training in first aid was necessary. A group of doctors left their professional positions and devoted themselves to education. In 1952, Maurice Ellis was appointed as the first “first aid consultant” at Leeds General Infirmary in England. In 1967, the Casualty Surgeons Association was founded, with Maurice Ellis as its president.^[2,3] In 1961, in the United States, Dr James DeWitt Mills, along with 4 assistant physicians, established 24/7 emergency care at Alexandria Hospital in Alexandria, Virginia; it was later known as the Alexandria Plan.^[4] In 1970, the University of Cincinnati launched the first emergency resident physician program in the world. In 1971, the University of Southern California became the first American medical school to establish a department of emergency medicine.^[5] History was made in 1979, when the American Board of Medical Specialties voted to make emergency medicine a recognized medical specialty in the United States.^[5]

In China, emergency medicine started relatively late. The Ministry of Health issued “Suggestions on Strengthening First Aid Work in the City” and “On the Release of the Construction Plan of Hospital Emergency Departments (Trial)” on October 30, 1980 and June 11, 1984, respectively. These 2 documents stipulated the work direction, scope, and tasks of the emergency department; thereby, laying the foundation for the construction of emergency departments in China. In 1985, Peking Union Medical College Hospital established the first postgraduate program in emergency medicine.^[6–8]

Current state of emergency medicine

Emergency medicine mainly involves the rapid assessment, treatment, and triage of critically ill patients, and has transformed from the emergency room to the emergency department or emergency center. Hospitals typically set up

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a relatively complete emergency medical system of “out-of-hospital emergency medical services, in-hospital emergency medical services, and critical care.” Numerous emergency diagnostic and treatment technologies, such as cardiopulmonary resuscitation, emergency percutaneous coronary intervention, continuous renal replacement therapy, left ventricular assistive devices, and extracorporeal membrane oxygenation, are applied in emergency medicine. Moreover, a growing number of qualified physicians have devoted themselves to emergency medicine, and several academic platforms have been established, which facilitate knowledge exchange.

With the continuous reform of the medical system and the comprehensive implementation and promotion of hierarchical diagnostic and treatment systems from medical reform, the development of emergency medicine is confronted with rare opportunities and more challenges. For example, the construction of emergency systems varies across nations and regions. Practitioners in emergency services have the vital task of establishing a complete emergency diagnosis and treatment system to maintain the daily health of the public and to satisfy the emergency demands of major public health events. It is necessary to move the front of first aid forward, carry out multidisciplinary cooperation, treat all types of critically ill patients, deal with public health emergencies, and boost hierarchical diagnosis and treatment work. Amid the rapid growth of modern medicine, advanced technology and innovative drugs continue to emerge. In many cases of emergency work, it is the timely, orderly, and efficient application of these technologies and drugs to the early treatment of critically ill patients that matters. Therefore, “process optimization and early treatment” is an important direction in emergency medicine research.

With the development of a medical discipline, each medical specialty is more characterized, and even some single diseases tend to form specialties.^[9] Following the law of medical development, emergency medicine also gives full play to specialty characteristics and the development of subspecialties.^[10] For example, in areas with a high incidence of cardiovascular diseases, emergency centers have subspecialty focus areas for cardiovascular diseases, and in rural areas with a common occurrence of acute poisoning, emergency departments of primary hospitals establish a subspecialty for the treatment of acute poisoning. In developing subspecialties, emergency medicine focuses on the advancement of diagnostic and treatment technologies for life-threatening diseases and integration with other subspecialties. The construction of high-quality subspecialties in emergency medicine is conducive to the development of new diagnostic and treatment equipment and technology.

Future of emergency medicine

The coronavirus disease pandemic has brought huge challenges to medical systems, especially emergency medicine.^[11] Elevating the capability of early identification, appropriate treatment, and life support for severe or critical patients will always be the core topics of emergency medicine.

Emergency medicine in the future will be characterized by continuous advances in practices, research, technolo-

gies, and so forth. In terms of clinical practices, problems such as inefficiency and crowding may arise and cause tension in emergency departments. The development of emergency medicine is still in its primary stage and is extremely uneven between rural and urban areas. The resolution of such issues and optimization of processes in emergency medicine can be realized by implementing an increasing number of equipment configurations, improving the structure of emergency medical personnel, and establishing a closer linkage between out-of-hospital and in-hospital emergency services. In essence, “process optimization and early treatment” manifests as an influential component in the development of emergency medicine. In the optimization of the emergency process, the stability of emergency medical professionals is a valuable resource. Upgrading clinical emergency care competence, including rapid response, effectiveness, and service attitude, and improving the skills of medical professionals in the emergency department are of great importance.

The demands for technology are certain to direct the course of emergency services, as the need for timely diagnosis and treatment of patients continues to grow. Information technology can be used to tap available resources and collect information on patients and disease management to aid emergency staff in real time via telemedicine. Specifically, in the absence of specialists or general practitioners on site, the vital signs of patients and critical information can be wirelessly transmitted to experts who can provide remote guidance that may be critical to saving lives.^[12] In addition, remote monitoring also enables hospitals to grasp the condition of patients at the earliest time, formulate emergency plans in advance, and ensure a seamless connection between out-of-hospital emergency and in-hospital treatment. By virtue of networks, the real-time transmission of medical devices that monitor information, ambulances' positioning information, and video footage from inside and outside ambulances can facilitate remote consultation and guidance. Moreover, the collection, processing, storage, transmission, and sharing of out-of-hospital emergency information can fully enhance treatment efficiency and service quality, thereby optimizing the process and mode of service.

Big data technology can fully explore medical information to aid in the management and decision-making of emergency care.^[13] One of the applications of big data in the medical field is the establishment of a cloud platform for emergency and critical care information management. Such a platform would collect the diagnosis-, examination-, and treatment-related information of patients from databases, such as an emergency logbook, a hospital information system, a picture archiving and communication system, a microbial detection and management system, and a pathology information system. Next, the data were classified, cleaned, extracted, and explored in depth using the platform. Based on this information, a teaching management system can be obtained, including a multidisciplinary triage management system, a critical care score and grading management system, and an early warning system for serious emergencies. The application of big data technology in emergency medicine provides medical practitioners with

access to various information databases for each individual and possible treatment options, which will greatly improve teaching efficiency and the ability to diagnose and treat related diseases.

Precision medicine is a medical model that fully considers individual differences in the genes, environment, and lifestyle of patients to achieve the most effective treatment and prevention of diseases. The emergency department is the first critical link in the clinical diagnosis and treatment of critical illnesses and infectious diseases, and individualized accurate assessment and prevention of disease susceptibility is a valuable research direction for precision emergency medicine.^[14] Acute infectious diseases are among the most common diseases in the emergency department. However, given the complexity of diseases, lag in detection technology, and lack of multidimensional clinical information integration technology, the diagnosis and treatment of common diseases such as community-acquired pneumonia remain stagnant. In addition, the emergence of drug-resistant pathogens and emerging microorganisms poses a challenge to empirical therapy protocols. Identifying pathogenic microorganisms quickly and accurately is critical for initiating individualized treatment plans and is also the core component of precision emergency medicine systems. The ideal method of monitoring the outbreak of drug-resistant pathogenic microorganisms in communities or hospitals is to analyze the genetic ancestry of pathogenic microorganisms through genome technology. One of the essential tasks of emergency medicine is to use clinical information to provide individualized diagnosis and treatment for cases without a clear etiology. To some extent, it is necessary to establish etiological diagnoses through emergency treatment processes. In addition to molecular etiology diagnoses based on pathogenic specimens (eg, throat swabs, sputum, and body fluids), diagnostic techniques based on omics information have also seen rapid advances, which will improve precision emergency treatment services. For the differential diagnosis of emergency and critical care illnesses, precision emergency medicine can enhance diagnostic effectiveness significantly with the help of multidimensional and omics data, thus creating the ideal conditions for individualized diagnosis and treatment.

With the combination of big data and precision medicine, information technology can promote the growth of scientific research and clinical work in emergency medicine, such as sequencing, information construction, data integration, and analysis, and improve the use of big data in emergency medicine. Under these circumstances, it is possible to achieve breakthroughs in the development of targeted drugs for precision therapy, complete the closed-loop service of precision emergency medicine, and establish a disciplinary system for precision emergency medicine in China.

Artificial intelligence can promote the growth of emergency medicine.^[15] Equipped with capabilities in prediction, analysis, and response, artificial intelligence systems can aid emergency staff in diagnosis and treatment. When artificial intelligence tools execute instructions, they can learn from big data through image recognition, speech recognition, human-computer interaction, physical sensing, and other means. After finishing

examinations quickly, artificial intelligence tools can formulate a relatively accurate diagnosis and individualized medicine. In addition, artificial intelligence can assist in locating potential risks and threats in advance. In some emergency events, artificial intelligence can assess the situation and predict the required medical services. Another example of artificial intelligence is the use of medical robots. Apart from their application during complex surgeries, medical robots can deliver objects to patients in quarantine and help avoid human contact during virus epidemics. In short, the use of artificial intelligence will undoubtedly benefit emergency medicine in the future.

As more countries are improving their emergency medical systems, the global scale of information exchange is empowering international emergency medicine. Promoting the quality of academic exchange among countries is a priority in the development of international emergency medicine. Moreover, the variety and complexity of emergency diseases pose challenges to timely and accurate emergency medical treatment, and require emergency medical staff to possess rich medical knowledge and accurate judgment.

Although the development of emergency medicine is confronted with quite a few challenges, it has entered the era of communication among various schools of thought. This journey provides opportunities to the field of emergency medicine. With the joint efforts and hard work of stakeholders worldwide, emergency medicine will accomplish more historic advancements.

Conflict of interest statement

Shujian Wei is the Executive Editor of *Emergency and Critical Care Medicine*. The author declares no conflicts of interest.

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