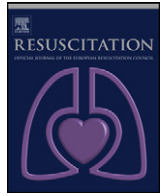




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International EMS systems

EMS in Taiwan: Past, present, and future[☆]

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ABSTRACT

Taiwan is a small island country located in East Asia. From around 1995 modern concepts of the EMS were imported and supported by legislation. Considerable progress has since been made towards the construction of an effective pre-hospital care system. This article introduces the current status of the EMS in Taiwan, including the systems, response configurations, funding, personnel, medical directorship, and outcome research. The features and problems of in-hospital emergency care are also discussed. Key areas for further development in the country vary depending on regional differences in available resource and population density. An analysis of the strength, weakness, opportunity, and threats of the evolving EMS in Taiwan could be an example for other countries where the EMS is undergoing a similar process of development and optimisation.

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1. Background

Taiwan, previously named *Formosa* (meaning beautiful island) by a Portuguese explorer in 1590, is a country consisting of a main island and some smaller islands located in East Asia off the south-eastern coast of China. The main island is 394 km long and 144 km wide, slightly larger than the combined areas of Massachusetts and Connecticut, or a little smaller than the Netherlands. The population of Taiwan was estimated at almost 23 million in July 2007, spread across a land area of 35,980 km², making it the 15th most densely populated country in the world.¹ In fact, the population density should be even higher than estimated because of the topographic character of Taiwan. A central mountain range geographically bisects Taiwan from north to south which results in two-thirds of the island being covered by forested peaks. Most of the population is distributed in four cities (Taipei, Kaohsiung, Taichung, and Tainan), as shown in Fig. 1. The uneven population distribution has led to disparities in regional resourcing and has influenced the level of development of the local emergency medical service (EMS) system.

2. Development of EMS in Taiwan

In the 1960s, a basic EMS system (mainly transporting sick and injured patients to hospital by ambulance) was started in Taiwan.² The system was delegated to police stations with neither well-coordinated communication to the hospital nor well-trained providers in pre-hospital care. Although some efforts were made, the situation did not alter for the better until 1990. In that year a formal emergency medical technician (EMT) training curriculum was initiated by pioneers of emergency medicine who had studied EMS abroad. This initiative was supported by the Society of Emergency and Critical Care Medicine in Taiwan. The year 1995 marked the beginning of modern EMS in Taiwan when a lot of important concepts of EMS were put into legislation, *The Emergency Medical Service Act*. The law designated pre-hospital care as a function of fire administration at the central and local level. It also regulated essential ambulance equipment and permitted EMTs acting as physician surrogates to provide different levels of care based on their levels of certification. In 1998, emergency medicine was recognized as an autonomous medical speciality by the Department of Health (DoH) in Taiwan. This landmark facilitated the further development of the EMS.

Over the last eight years, Taiwan's EMS has undergone rapid development, including the implementation of off-line medical direction, establishment of national disaster response teams, and the introduction of automatic external defibrillators (AED) by EMTs. The EMT-paramedic (EMT-P) training program began in 2002,

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Fig. 1. The geographic location and topographic character of Taiwan. These features have influence on the further development of EMS in different districts (please see the text for detail). Note the picture was cited from Microsoft MapPoint Service Online. Accessed on 20 July 2008, at <http://www.englishintaiwan.com/images/map.taiwan.jpg>.

enabling the EMS to provide fire service based advanced life support (ALS). New initiatives are close to introduction. These include medical directorship, public-access AED programs, and a nationwide standard for computerized reporting of out-of-hospital cardiac arrests (OHCA) and major trauma.

3. Taiwan EMS: the current state

3.1. Pre-hospital: governmental versus private systems

The pre-hospital care system in Taiwan can be categorized into governmental or privately supported services. The governmental services are all fire-based with three levels of care providers (EMT-I, EMT-II, EMT-P), and are activated by a universal access number (119). In some cities, hospital-based ALS teams, consisting of a physician and a nurse, participated in pre-hospital care of the critically ill but this was temporary and gradually shifted to a fire service based response soon after the introduction of qualified EMT-Ps into the system. However, due to the limited number of EMT-Ps, complete pre-hospital ALS only exists in some urban areas. The primary responsibility of the governmental EMS system is to deliver sick and injured patients to hospital and not for secondary transportation (i.e. between hospitals or back home). In contrast to the free governmental service, the private service charges patients. Most only have EMT-1 or EMT-2 crews in their ambulances and they play a complementary role to the governmental service by providing inter-hospital transport. For sicker patients, a physician or nurse from the transferring hospital is also required to staff the ambulance. As a local custom, privately supported ambulances also

transport dying patients home from hospital because many people wish to pass away at home.

3.2. Pre-hospital: response, transport, and funding resources

The public demand for the EMS is increasing. The latest data from the National Fire Agency (NFA) in the Ministry of the Interior³ shows a 10% annual increase in EMS demand over the last ten years. The annual EMS call volume was 720,797 in 2007, which is equivalent to 8.7 calls per 100,000 persons per day, or approximately half of the number of EMS calls seen in urban Taipei, the ALS demand was estimated at around 9–16% of EMS calls^{5,6} and the average response times were 4.1–4.9 min,^{7,8} with mean call-to-first shock times for cardiac arrest of 9.3 min.⁷ In a rural area, the average response time was found to be longer, up to 6.6 min.⁹ A bypass policy for major trauma or severe illness (e.g. stroke or acute coronary syndrome) is recommended by academic societies but not fully implemented because of insufficient coordination and uncertain accountability between the jurisdiction of the DOH and NFA.

Land ambulances are the main transport mode in the Taiwan EMS. Aero-medical and helicopter transport is limited to emergency events with poor access (i.e. major incidents, off-shore island inhabitants or transplant organ procurement), and requires inter-agency coordination. A few private companies provide efficient aero-medical evacuation but at a much higher cost. The main funding of EMS operations is from general taxation. There is another important resource for public EMS in Taiwan: donations from Taoism or Buddhism temples. In many jurisdictions, ambulances

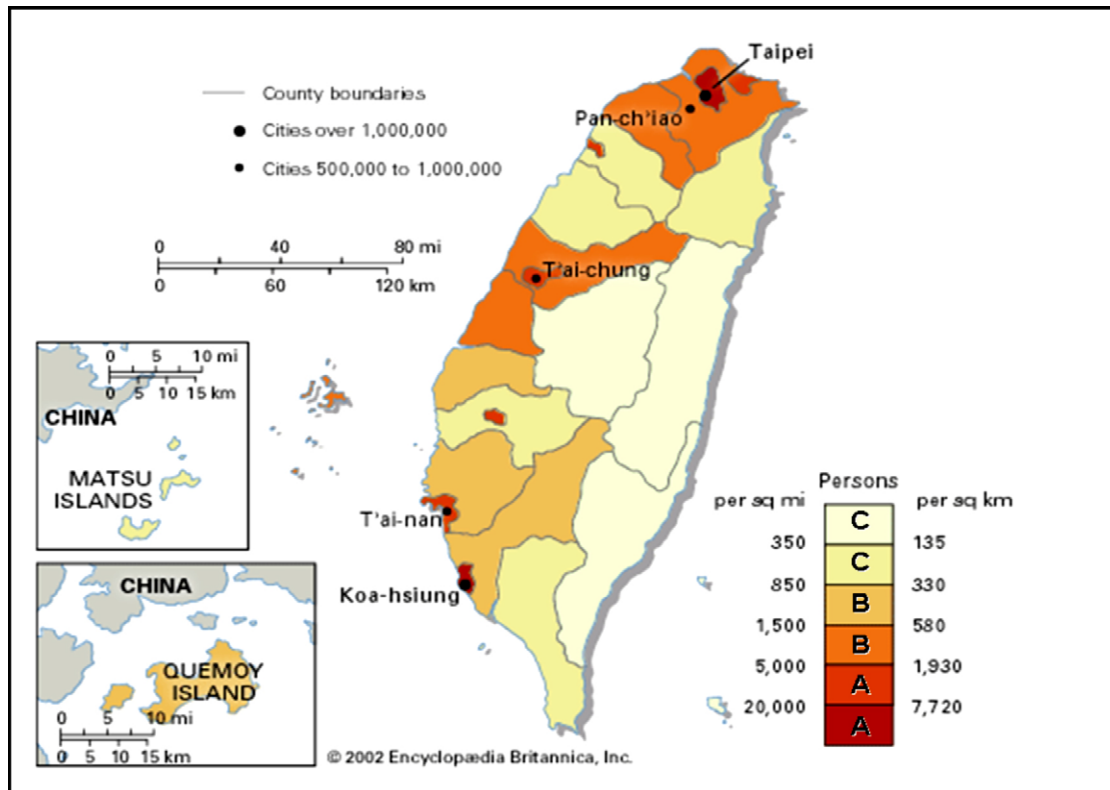


Fig. 2. Three models of EMS regional design based on population density. For models A, B, and C please see the text for details. The figure was modified from site below: "Taiwan: population density." Online Map/Still. Britannica Student Encyclopædia. Accessed on 21 July 2008, at <http://student.britannica.com/eb/art-73666>.

are funded by donations from Buddhism or Taoism temples, as indeed is most EMS equipment. This is in line with their obligation to charity. In return, ambulances and equipment bear the names and logos of the temples or charities to honor their contributions.

3.3. Pre-hospital: the EMTs and medical directorship

In 2007, there were a total of 9251 EMTs in governmental fire-stations in Taiwan, responsible for fires and pre-hospital care.³ Over 97% of them were at EMT-1 or EMT-2 level. In July 2008 there were only 310 EMT-Ps (paramedics) across the country, and most were employed in urban areas. Since the development of the EMS system in Taiwan was modelled on the North American paradigm, the pre-hospital care providers and their training program resemble those of their North American counterparts. The national standard training program of EMT-1 is 40 h to ensure competency in vital sign measurement, basic life support (BLS) skills and AED operation. The curriculum of EMT-2 level requires 280 h of training and, in addition to the EMT-1 material, includes ECG monitoring, application of the laryngeal mask and PASG (pneumatic anti-shock garment), and some medications, e.g. oral glucose water or intravenous saline. In addition to firemen, volunteers and crews of private ambulance companies are also required to certify as EMT-1s and EMT-2s.

For entry to the EMT-P course (the highest level of pre-hospital care provider), most entrants are selected from the best members of the fire-based EMT-2 course because at present training costs are completely supported by the government. The duration of the curriculum for EMT-P is 1280 h. The course content is extended to important concepts of medicine, advanced airway management, advanced cardiac life support, pre-hospital trauma life support, paediatric advanced life support, disaster man-

agement, and HAZMAT procedures (hazard identification, action plan, zoning, managing the accident, assistance and termination). They are also required to perform two internships during the training: to practice medical skills under the tutelage of registered nurses and physicians in a tertiary emergency department and to participate in ambulance runs with experienced paramedics in the field. Finally, after almost nine months of training, they must pass the examination approved by DOH to get the licence. All EMT levels are required to recertify by attending approved refresher courses within a prescribed period of time.

In 1995, the *Emergency Medical Service Act* of Taiwan provided implementation of medical oversight for pre-hospital carers at all levels. Physicians on the medical consulting committees (required by law) are responsible for the standards of patient care, including establishment of pre-hospital medical protocols and assistance in education of EMTs. However, a lack of specific tasking and full-time positions in the fire department for medical directors has resulted in the medical oversight remaining incomplete in terms of protocol revision, quality assurance, system design, and direct medical oversight. The situation improved after July 2007 when the amended *Emergency Medical Service Act* stipulated that local fire departments appoint an identifiable physician for medical oversight.¹⁰

3.4. Pre-hospital: the dispatcher

EMS dispatch in Taiwan is performed by experienced fire fighters. However, there are neither formal training courses nor certification available for EMS dispatchers. Moreover, the standard dispatcher protocol and decision-making steps for delivering ALS or BLS are not well-established in many systems. Therefore, appropriate dispatch performance on ALS cases was only 37%, and over triage

(i.e. dispatching an ALS team to a BLS scene) was very common.⁵ Besides, the numbers of dispatcher-assisted bystander CPR in OHCA were also low according to data acquired in metropolitan Taipei.¹¹ These drawbacks indicate that a standard ALS dispatch protocol and dispatcher training programs should be established in Taiwan.

3.5. Pre-hospital: outcome research

An advantage of the Taiwan EMS is that the system is still growing and receiving considerable attention from the public and government. During this developing process, EMS researchers potentially have the chance to exam the effectiveness and outcome of many newly implemented strategies, such as ALS performance on CPR quality,^{12–16} their effect on outcome of OHCA and cost-effectiveness analysis.^{17,18} Since Taiwan is located at the Western Pacific seismic belt near mainland China, researchers also have opportunities to evaluate the EMS response to catastrophic events like earthquakes or public health emergencies like SARS (severe acute respiratory syndrome).^{19–21} This type of research can be used to optimize the pre-hospital care system with data derived from relevant local events. To date most studies have been carried out only in metropolitan Taipei. Lacking a universal, well-established infrastructure in the EMS, data collection for quality assurance and outcome research at the national scale remains currently unavailable.

4. In-hospital: the emergency department (ED)

In each jurisdiction, there is an EMS Advisory Committee for the planning and integration of pre-hospital and in-hospital emergency department care. Hospital EDs that are determined as capable of receiving ambulance patients are designated as EMS response hospitals by law. Before transporting patients to a hospital ED, EMS personnel will contact the nearest ED by radio. When the destination ED is overwhelmed, EMS patients may be re-directed to other nearby EDs.

Since emergency medicine was approved as a medical specialty in Taiwan, the predominant workforce in the ED are emergency physicians. Based on hospital accreditation in Taiwan, both doctors and nurses working in the ED are required to certify in ACLS, ATLS, or equivalent trauma training courses. Some tertiary hospitals are allowed to accept registered residency and rotating trainees including student nurses and EMTs. The major problem of EDs in Taiwan is of significant overcrowding, especially among many tertiary hospitals. Two systemic causes contribute to this condition: the limited patient flow and undeveloped interfacility transfer rules. Under the national insurance of health (NIH) for all inhabitants, the medical cost for users is relatively low in Taiwan compared to other developed countries. People can seek medical care in any level of hospital they wish, with little difference in cost. Political and cultural considerations make the attendance/triage of patients with non-serious problems to suitable EDs impossible. Solutions for overcrowding are proposed and include creation of a large holding unit, pre-established rules for admission, priority-setting and active interfacility transfer.²²

Many evidence-based life-saving strategies for severely sick patients including hypothermia for post-resuscitation care or early goal directed therapy for severe sepsis have been started in some hospitals. Although restricted financial resources and overcrowded EDs limit the practices above, there is a paradoxical phenomenon of the use of ECMO (extra-corporeal membrane oxygenation) in resuscitation in Taiwan. One of the most notable features of tertiary EDs is the widespread use of E-CPR (ECMO-integrated cardiopulmonary resuscitation) for cardiac arrest and its effects on outcome.²³ The intervention initially arose from a

scientific interest in one medical centre, NTUH (National Taiwan University Hospital), but is now popular in many hospitals because of initial favorable outcome data, patient demands, and payments from the NIH.

5. Taiwan EMS: future design

Diversity in population density and its geographical distribution heavily influence the distinct blueprints of Taiwan EMS development in the future. It can be divided into three models: the metropolitan, the outskirts, and the rural system, as shown in Fig. 2. In the metropolitan model (areas marked A), both EMS personnel and hospital capacity are abundant. The goal should focus on the full implementation of more evidence-based advanced pre-hospital interventions and area wide disaster preparedness, and improving the precision of pre-hospital triage and transport. In the rural model (areas marked C), where pre-hospital and in-hospital EMS resources are limited, the emphasis should be placed on shortening the EMS response time and provision of good quality BLS-D care. The local public safety agencies should consider emergency healthcare services as a primary responsibility, not a role secondary to fire fighting or policing. The government should develop aero-medical capability to reduce the time to definite care for critically ill patients in these areas. Public education on awareness of severe illness and bystander CPR is also helpful. For the outskirts model (areas marked B), regionalized care for conditions such as trauma or stroke should be facilitated. EMS personnel should distribute the patient flow efficiently, including following the bypass rules, even cross-district, and streamlining the interfacility transfer network.

Beyond all regional aims above, there are two important tasks that must be emphasized in all regions. First and foremost, a universal well-established infrastructure for quality assurance is of paramount importance for the EMS in Taiwan so that the quality of care and the outcomes of many new integrated interventions in the EMS can be evaluated. Another priority would be to coordinate various components in the EMS. Historical events show that coordinating services across county lines is particularly challenging. EMS personnel should also promote cooperation in solving problems arising from incidents that cross jurisdictional lines, such as near municipal and county border areas.

6. Conclusion

The EMS is unique in straddling medical care, public safety and public health. Being a young system in Taiwan, the EMS has gained momentum in the last decade. The strength of the system is that the development process provides opportunities to integrate new interventions and to evaluate their outcomes. The weaknesses are an immature data collection system for quality assurance and insufficient coordination in the leadership of government health-care between the DOH and NFA. The geographic and demographic characteristics such as frequent natural disasters, public health emergencies and an aging population provide an opportunity to create an efficient system. EMS personnel need to be able to show the benefits of their work in terms of improved patient outcomes and patient satisfaction. This will gain the respect and support of other health professionals and make the system a sustainable one.

Conflict of interest

All authors declared no potential conflicts of interest in this report.

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