

## Ambulances: from antiquity to modern times

### 救護車：由古代至現代

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There has been much evolution and progress in the Emergency Medical Services systems worldwide. Today, it is not just a basic means of transporting the sick and injured to hospitals, but represents organised care and management of patients in the prehospital environment. Survival rates, in many instances, depend upon the proper management of these out-of hospital casualties and patients before they arrive at a healthcare facility. Issues such as state-of-the-art treatment, evidence based care protocols, medical accountability and professionalism have surfaced prominently. From the days of the first land and air ambulances, we have indeed come a long way. (*Hong Kong j.emerg.med.* 2005;12:261-265)

在世界各地，緊急救護服務系統有着很大的演變及發展。今天，它已不單只是運送病人及傷者到醫院的基本工具，而是在院前的環境中，代表有組織的病人護理及治療。在很多情況下，這些院前傷者及病人的生存率，均是依賴在他們抵達醫療設施前得到正確的治理。議題如最優良的治理，以證據為本的治療方案，醫療責任制及專業精神等已顯著地浮現。從有第一輛救護車及救護飛機的時候開始，我們實在已走過很長的路途了。

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**關鍵詞：**救護飛機、緊急救護服務、歷史

## Introduction

Prehospital care and transportation issues have existed since man learnt to hunt and make war. The basic elements of prehistoric response to injury still guide the current ambulance and Emergency Medical Services (EMS) programs. There has always been the recognition of the need for action, as well as the evolution of a system of communications, treatment and transportation to reduce morbidity and mortality.

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## The development of ambulances

An ambulance is a vehicle or means of carriage designated for the transport of the sick and injured to a medical facility. Throughout history, men have devised various methods to transport the ill and injured. Hammocks were readily available and widely used for centuries. The Romans and Greeks later used chariots to transport the injured. Around 900AD, hammocks were fixed to wagons to be used for carriage. In 1100AD, the English started using horse litter, which comprised of two horses with special harnesses that suspended a bed between them. Camels and mules were also used for this purpose.<sup>1</sup>

Ferdinand and Isabella of Spain introduced *ambulancias* or field hospitals in the 1400s. This represented the first time medical and surgical supplies

were put in special tents to treat the wounded on or near the battlefield. It then took another 300 years to develop and evolve field hospitals, from where aid could be sent to the injured on the field.<sup>1,2</sup> Dominique Jean Larrey, a French surgeon of the Napoleonic era (1793-1815), developed light-weight two-wheeled wagons to transport wounded soldiers to hospitals and also to bring surgeons to the battlefields. These were known as 'flying ambulances' as they stayed with the 'flying artillery' on the battlefield. Before Larrey, army regulations required the clumsy and heavy wagons to be stationed at the rear of the armies only.<sup>3,4</sup>

During the American Civil War (1861-1865), regimental musicians or soldiers who were not good fighters were placed on ambulance duty and served as medical assistants. They helped with the removal of the wounded from the field. They acted as stretcher-bearers who delivered the casualties to the primary centres for preliminary treatment before they were transferred to field and general hospitals for specific management.<sup>2,5,6</sup> The transfer was done by train or boat. Trains' facilities could range from a bed of straw or hay on the floor of a freight car to special bunks.<sup>7</sup> Some trains served only as a large ambulance whilst others had cars with kitchens, medical stores and operating facilities. Water travel was by a variety of boats and steamships outfitted as hospitals. This became the accepted way for the military to transport casualties.<sup>2,5</sup>

In 1864, the US Congress passed the Ambulance Corps Act. It was also known as "an Act to establish a unique system of ambulances in the armies of the USA". Ambulances then came under the jurisdiction of the head of the medical department who was responsible for the administration, personnel and vehicles. It spelt out who was responsible for each phase of the ambulance system.<sup>8</sup> During the 1864 Convention in Geneva, an agreement was reached among several European nations to recognise the neutrality of hospitals, of the sick and wounded, of all persons connected with relief services and the adoption of a protective sign or badge.<sup>8</sup> In the United States, a similar organisation had been functioning during the Civil War. The Sanitary Commission, as it was known then,

became the American Red Cross some 20 years later. This was the model until World War I.<sup>1,8</sup>

In 1869, Edward Dalton, a United States army surgeon founded an ambulance service at Bellevue.<sup>9</sup> The service received 1,401 calls that year and this increased to 4,392 calls by the year 1891. The vehicle was a lightweight carriage, run by horses with a moveable floor that could be used to receive and remove patients. They were also equipped with stretchers, handcuffs and straitjackets. Under the driver's seat were brandy, bandages, splint material and a bottle of persulfate of iron.<sup>9-11</sup>

In 1899 the first motorised ambulance came on the scene. It had advantages over the horse-drawn prototype.<sup>1,10</sup> It was faster and smoother for the patients, who were now transported with greater ease and safety. It was able to move at 16 miles per hour. There was sometimes a doctor in the back of the vehicle who could communicate with the driver via a speaking tube. There were electric lights as well. This ambulance had the unhappy honour of transporting President McKinley after he was shot in 1901.<sup>7</sup>

In 1937, Hess and Eisenhardt of Cincinnati, Ohio built the first air-conditioned ambulance in the USA.<sup>1</sup> Parisian taxis and funeral home transport vehicles then came to be used for transporting patients as well. Any readily available vehicle and volunteers with varying degrees of training rendered care to casualties.<sup>1,7</sup>

In 1965, the Accidental Death and Disability paper stated that the style of ambulance in current use was inadequate.<sup>8</sup> More space was needed for the patient, attendant and equipment. Four years later, 'Medical Requirements for Ambulance Design and Equipment' was formalised and this was followed by the EMS Systems Act in 1974. The latter required that communities receiving federal funds had to meet the new regulations.<sup>8,12</sup>

From the early 1970s to the late 1990s, prehospital emergency care had grown to become more sophisticated. Today's system includes, in the United States, three levels of state certification for professional emergency medical technicians, licensed ambulances

stocked with the latest technical medical equipment, paid county and private care providers and some dedicated trained volunteers. An organised system of medical control and a system of designated trauma centres are also in place.<sup>1,12</sup>

Three chassis style met the recommended criteria and these are still in use today.<sup>7,12</sup>

Type I: small trunk body with a modular compartment

Type II: a van body with a raised roof

Type III: a van chassis with a modular compartment

Later, attention was focused on the air quality in the ambulance. Air circulation and filtration was gradually improved to protect patients and paramedics.

Specialised care provided by ambulances such as prehospital cardiac care came about in the 1960s.<sup>13</sup> Prehospital cardiac care was first established in Belfast, Northern Ireland. This represented a radical break from existing practices. This program "moved" the coronary care unit into the community by treating the early complications of acute myocardial infarction (AMI). A physician and a nurse staffed the ambulance and they were able to demonstrate that resuscitation could be performed early in cardiac arrest patients. This idea of prehospital cardiac care then began to spread to other countries.<sup>13</sup> The first program in the United States, stationed at St Vincent's Hospital in New York, began in 1968 and was modelled after the Belfast program. The physician-staffed model however, was not widely initiated in the United States. In fact, from 1969, programs using trained personnel known as paramedics began in Miami, Seattle, Washington, Ohio and a few other places. These paramedics-based programs were designed to treat not only the early complications of AMI, but also to perform resuscitation for out-of-hospital cardiac arrest. Most of these programs were based in fire departments. Prehospital cardiac care has indeed evolved in the last three decades and some of the notable developments included tiered response system, use of defibrillators and automated external defibrillators (AED) and 12-lead electrocardiographic telemetry.<sup>13</sup>

Today the American College of Emergency physicians (ACEP) and the National Association of Emergency Medical Services Physicians (NAEMSP) have put forth that patient care and safety are the two priorities for all EMS systems.<sup>14</sup>

## Air ambulances

The first air transport of a patient occurred sometime around 1870 in Paris, France. Balloons were used to transfer soldiers wounded in the Franco-Prussian War.<sup>15,16</sup> Marie Mavingt of France, a free balloon pilot, a surgical nurse and the third woman in the world to receive her fixed wing pilot's license, was a true visionary, ordering the construction of an air ambulance in 1912, and she devoted the remainder of her life to seeing its full acceptance in the medical armamentarium.<sup>17</sup> Marie was the cofounder of the French organisation Les Amies De L' Aviation savitaire (Friends of Medical Aviation) and she also devised metal skis for air ambulances. She helped establish the civil air ambulance service in Morocco. Primitive biplanes were then used for air transport some 70 years ago. The ability to fly over obstacles of battlefields was a major development for both the military and civilian communities.

A French medical officer, Eugene Chassaing, first adapted French military planes for use as an ambulance, in which two patients were inserted side by side into the fuselage behind the pilot's cockpit.<sup>15</sup> The United States also used airplanes to evacuate casualties during World War I, but the fuselages were too small to accommodate the stretcher and the open cockpit exposed patients to the elements. In 1918, a Curtis JN-4 "Jenny" biplane was converted into an airplane ambulance by modifying the rear cockpit to accommodate a standard army stretcher. In 1921, the Curtis Eagle aircraft was built to transport four patients on litters and six ambulatory patients. This, however, crashed during a storm killing seven people.<sup>18,19</sup>

In 1922, Colonel Albert Truby, a US physician enumerated the potential uses of the airplane ambulances:<sup>18</sup>

1. For the transport of medical officers to the site of injury and also to bring casualties from the site of injury to the hospitals
2. To transport patients from isolated and remote site hospitals to a general hospital for definitive care
3. For the transport of the seriously injured to hospital during war time
4. For the transport of medical supplies in an emergency

The war demonstrated strongly the need and necessity of air evacuation. The first medical air squadron was established in 1942. A flight nurses group was also set up to help with the proper transport of casualties.<sup>15</sup> An important observation was made during this period: the casualties did not do well if prematurely placed on long flights. The patients were stabilised in combat hospitals and then transported to offshore islands to recuperate before returning to duty or being sent home.<sup>20</sup> Post-war, developments continued.

Helicopters were used in the Korean War (1950-53) and this was expanded further in the Vietnam War (1964-75). With the advent of vertical flight, the need for conventional runways was obviated, allowing casualties to be transported directly from the site of injury.<sup>15,16,21,22</sup>

The first commercial Helicopter EMS Program used for patient transport started in Denver, Colorado in 1972. Since then these programs have increased dramatically worldwide. In the USA alone, by 1995, there were an estimated 300 Helicopter EMS operations.<sup>23</sup>

Training and patient care standards improved by leaps and bounds in the 1980s and 1990s. During this time, 'medical evacuation' began to be differentiated from 'aeromedical evacuation'. The former refers to the emergency transport of patients to the nearest appropriate facility prior to definitive treatment. 'Aeromedical evacuation' on the other hand is the long distance (more than 300 miles) transport of patients after adequate treatment has been rendered to ensure a successful transfer.<sup>15,16</sup> Medical evacuation was used extensively in operation 'Just Cause' in December 1989

(to oust Panamanian dictator Manuel Noriega), the Gulf War and many other contingency operations. It also has widespread applications in humanitarian-civic-action operations. It is utilised in many rescue missions from natural disasters such as earthquakes and floods.

Today, not only military air evacuation planes exist but also many civilian airplanes are widely utilised. Ambulance transport including the air transport of patients is used for taking patients from one medical facility to another where better facilities exist. We have come a long way from the small airplanes to jet aircraft with a medical platform that supplies oxygen, electrical capabilities and with a crew trained in critical care in the air skills.

## Conclusion

During the last two decades of the twentieth century many changes and evolution have occurred in EMS systems worldwide. It has progressed from just a basic means of transportation to tackling issues such as the state-of-the-art prehospital management, medical accountability and prehospital care professionalism.

We have indeed come a long way since Edwin Smith's papyrus of 1500 BC (triage and treatment protocols) and the Babylonian Code of Hammurabi (prehospital treatment of the injured) but there are still a lot of changes, developments and evolution going on to this day.<sup>24,25</sup>

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