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Analysis of Emergency Medical Systems Across the World

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Abstract

This Interactive Qualifying Project (IQP), prepared for MIRAD Laboratory, provides a basic understanding of the role of emergency medical services (EMS) in selected countries around the world. An overview of the Anglo-American and Franco-Germany EMS systems and their structure, functions and governing standards of operations are presented. A substantial number of countries around the world are using these systems as a framework to provide quality care in pre-hospital or emergency medicine. The Franco-German system is a Physician-EMS-based model that enables a Doctor and EMS to evaluate and treat a patient on the scene of a medical emergency. The patient can be taken to a hospital or clinic if further evaluation is required. The Anglo-American model, on the other hand, consists of ambulances staffed with Emergency Medical Technicians (EMTs) and Paramedics trained in Basic, Intermediate and Advanced life support. They provide pre-hospital emergency care, including stabilization, intervention and the transport of the patient to a hospital or clinic for further evaluation by emergency Doctors or Physicians. The IQP presents analysis of the Franco-German and Anglo-American models. Selected countries with varying economic, political, and geographic backgrounds are studied. These countries include the United States, the Sultanate of Oman, Germany, Portugal, the People's Republic China, and South Africa. This IQP presents how each of these countries have utilized modified versions of the two models to fit their emergency medicine practices and capabilities. The derived results provide an opportunity for the IQP team to appreciate the social impact of pre-hospital services and the ethical challenges that are involved in delivering continuous quality of patient care in a sustained manner.

Table of Contents

List of Figures

List of Tables

Acknowledgment

We would like to thank Stephen Hayes and his colleagues at UMass Memorial Medical Emergency Medical Services. Their effort provides us the opportunity to learn about the daily challenges of balancing the quality of care, ethics and responsibilities. They provide us an overview of EMS services, training and education of Basic Life Support (BLS), Intermediate Life Support (ILS) and Advanced Life Support (ALS) or paramedics, and their respective roles and duties in ambulatory care. We are also very thankful to Neil Blackington of Boston EMS and its ambulance mechanics for all their insightful contribution in helping us to expand our understanding of pre-hospital services and their social impact input. Finally we thank Professor Mustapha S. Fofana for his role as our project advisor and mentor in this project.

CHAPTER 1. EMERGENCY MEDICAL SERVICES AND THEIR MODELS

1. Introduction

There is an increasing demand for Emergency Medical Services (EMS) in the United States and around the world. To respond to this growing demand, the EMS communities require adaptable and sustainable model systems that encompass unified standards of practice, training and results with minimum risk. Millions of patients with simple or complicated conditions or injuries seek pre-hospital care around the world. EMTs with knowledge of Basic Life Support (BLS), Intermediate Life Support (ILS) or Advanced Life Support (ALS) or First Responders, as they are generally called in the United States, provide rapid assessments and treatment of the sick and injured prior to transporting them to a hospital or clinic for further evaluation. Considerable knowledge, skill, and judgment are required to provide quality ambulatory emergency medical services. High quality emergency medical services and first responders are important part of any health care system. Many studies of pre-hospital services place greater emphasis on human factors, efficiency and continuous refinement of standards of practice.

Worldwide Emergency Medical Services are divided into two main models: (1) the German-Franco Model, in which an ambulance is staffed by physicians, and (2) the Anglo-American Model, where ambulances are staffed with EMTs trained in BLS, ILS or ALS. In both models, effort is made to use modern techniques, tools and technologies to reduce medical uncertainties so as to attain the highest possible quality of patient-centric pre-hospital care. Many countries around the world are using these ideas to support and improve their pre-

hospital services and emergency medicine. Oftentimes, in most countries, compromises are made in order to provide efficient pre-hospital services while staying within budgets and the capacity of existing infrastructure. Individual countries also have different environmental performance and public health issues to contend with. The lack of trained pre-hospital providers, modern equipment and ambulance vehicles for example, also account for the challenges and short comings to provide quality emergency medical services. For many countries, the Anglo-American and Franco-German models are the guiding framework for their emergency medical services and continuing advancement in providing quality emergency medicine. Several significant factors, such as the improvement of EMS access, telemedicine and greater availability of pre-hospital services in rural areas, have resulted from the use of the EMS models.

The objective of this project is to provide an overview of EMS systems across different countries in different parts of the world. This IQP focuses on countries from the continents of Africa, Asia, Europe, the Middle East and North America. In North America, this project studies the EMS systems in Canada and the United States. This project considers the EMS systems of European countries, namely Portugal, the United Kingdom, Germany, Greece, and Lithuania. In Africa, country of South Africa was considered. In the Middle East, the EMS system of the Sultanate of Oman was evaluated. This project studies the EMS systems of the People's Republic of China, Hong Kong and Taiwan in Asia. The selection of these countries is based upon their distinctive differences among them in terms of their economic, political, and geographic backgrounds.

We describe how the Franco-German and Anglo-America models have been used by these countries to modernize their emergency medical systems. An overview of the social impact of emergency medicine and balance of ethics between standards of care and the ability to stay within budget is presented. The four chapters of this project provide an opportunity for the readers to understand the development and effectiveness of Emergency Medical Services in the selected countries. In Chapter 1, the report conveys the general purpose of the project, its motivation and objectives. Chapter 2 presents an overview of the state of emergency medicine in the selected countries. Evaluation was completed on how these countries continue to improve their emergency medical systems using the two models. Chapter 3 presents a comparison among the EMS services from selected cities in the United States of America. In Chapter 3, an analysis of the Franco-German and Anglo-America EMS Models in terms of their applications in in the selected countries is presented. The last chapter discusses the conclusion of the project and recommendations for future project work in pre-hospital care.

CHAPTER 2. EMS SYSTEMS AROUND THE WORLD

2. Introduction

There is a growing realization worldwide that nations will face major challenges to protect their citizens from an increasing number of health threats initiated by man-made or natural emergencies and disasters. The lessons learned from hurricane Katrina, the Fukushima Daiichi nuclear disaster, hurricane Sandy and the earthquake in Haiti are still fresh in our minds. When national and international doctors and emergency personnel arrive at medical emergencies or disaster scenes, they are often confronted with changing demands and safety threats created

by environmental changes, uncertain emergency scenarios and medical challenges. EMS providers are expected to render effective life-saving evaluation, intervention, stabilization and treatment that are consistent with existing standards and codes. Emergency personnel must be properly trained and equipped with suitable equipment, tools and communication systems to ensure that the highest quality of care, safety and reliability are attained before, during and after a medical emergency event (see the references [8-17]). Many countries have embraced modified versions of the Franco-German and Anglo-America EMS models to improve their pre-hospital care (see the references [6, 30, 42, 43, 45-54, 56). There are continued innovations to improve the models so as to address the many challenges facing pre-hospital providers (see the references [19-27]). The rating cards of emergency medicine by the American College of Emergency Physicians and public scrutiny and attention to greater safety and reliability in pre-hospital or emergency medicine care also place more emphasis on identifying measures of quality, risks and performance [19-20, 22-27].

2.1 Africa

Africa is the second largest continent in the world, with an area of 30,065,000 km^2. It has the second largest population of any continent, clocking in at 1,022,234,000 people in 2010. Africa has a rich history, with the home of the world's first great civilization which dates back to 3300BC. It is also known that Africa is the hottest continent on earth. Africa also contains some of the World's largest and fastest land animals, including the African elephant and the cheetah. Within the continent of Africa, the EMS system in the country of South Africa is studied.

2.1.1 South Africa

South Africa is a country with a total area of 1,214,000 km^2, which is somewhat less than twice the size of Texas. South African major cities include Johannesburg, Cape Town, Ekurhuleni, Durban and Pretoria. However, it is very interesting that South Africa has more than one capital. The capitals are Pretoria, Bloemfontein, Cape Town and Johannesburg being the main capital. Figure 1 contains a map of the continent of Africa in which South Africa is shaded green. South Africa is located at the southern tip of Africa and covers less than one fourth of the African continent as shown.

Figure 1: A map showing the location of South Africa

The population of South Africa was at 48,800,000 as of 2008. As one of the wealthiest countries in Africa, South Africa had a Gross Domestic Product (GDP) of 273.9 billion dollars in 2008. In 2012, South Africa was spending 9.2% of its GDP on healthcare. In 2004, the country

had a physician density of 0.77 per 1,000 people. The hospital bed density is 2.84 per 1,000 people. Up until 1990, Emergency Medical Services in South Africa were run by fire departments and focused primarily on providing basic medical care (MacFarlane, et al. [36]). In 1977, the four existing provincial administrations were assigned the responsibility of providing EMS to South Africans. During this time, EMS in South Africa was absent in many parts of the country. Regulations for EMT certification and their training were established by 1994. South African EMS is funded at a national level, with the government allocating funds for use by the provinces. Rural areas are not as well serviced by EMS in South Africa due to budgetary issues and old equipment. In terms of cost, patients who earn money below a certain threshold qualify for free EMS care (MacFarlane, et al. [36]).

EMS in South Africa is reached by calling '10177', a regional call center, or '112' (for cell phone users). As of 2005, there was no formal training for dispatchers. Some call centers use software to coordinate triage and dispatch of vehicles. Figure 2 shows a typical South African ambulance at a rugby match.

Figure 2: An ambulance belonging to ER24 EMS at a rugby match

There are four primary levels of EMTs in South Africa. Basic ambulance assistants (BAA) who are trained for at least two months can provide selected BLS services. BAAs are capable of using automatic external defibrillators and performing CPR, first aid and simple trauma management. Ambulance Emergency Assistants (AEA) trained for at least 3 months, and exclusive of BAA training. They are able to administer intravenous glucose, insert intravenous lines, use manual defibrillators, and provide nebulization for asthma. Critical Care Assistants (CCA), also known as paramedics, train for at least 9 more months. Alongside the skill sets of the BAAs and AEAs, CCAs are capable of providing advanced cardiovascular life support, advanced trauma life support, and pediatric advanced life support. By their certification, the CCAs can administer a selected range of pre-hospital medications and perform advanced airway management (MacFarlane, et al. [36]). South Africa also has a fourth level of training that consists of a 3 year program at post-graduate technical college. EMTs who participate in this

training program study basic medical sciences and how to provide emergency care. Graduates of this program also receive a large amount of practical experience and medical instruction, thereby making them a formidable competitor with other EMTs in the world. This fourth year of training provides a South African EMT with a Bachelor of Technology degree (MacFarlane, et al. [36]).

2.2 Asia

Asia is the largest continent worldwide with an area of 49,700,000 km^2. It covers approximately 60% of the World's total land area. Its highest point is known as Mount Everest, which is also the highest point on the planet. Additional to Asia's enormous size, and its highest point, it also contains the largest amount of population on earth. Its population exceeds 4 billion human inhabitants, a quarter of which is from China. In this section the EMS systems in China, Taiwan, and Hong Kong are considered.

2.2.1 Hong Kong

Hong Kong is a Special Administrative Region (SAR) of the People's Republic of China. It is bordered by the South China Sea and China and has a total area of about 1,000 km^2. Figure 3 shows the location of Hong Kong along south coast of China.

Figure 3: A map with an arrow pointing to Hong Kong

In 2008, Hong Kong's population was estimated to be around 7 million people. Its Gross Domestic Product (GDP) was $219.3 billion in the same year. EMS in Hong Kong was operated primarily by the Hong Kong Fire Brigade until 1970, at which time EMS was spun out into a separate organization known as the Ambulance Command. Over the years, Hong Kong has used its experiences from its interaction with other international emergency medical services to provide ideas for improving its own service. In the 1990s, Hong Kong worked to upgrade the skills of its EMS personnel to world paramedic standards. Further development continued in the 2000s, with the Hong Kong government providing financial support to further upgrade the skills of emergency medical personnel (Graham, et al. [23]).

Ambulances in Hong Kong operate out of ambulance depots. The 30 ambulance depots in Hong Kong reside primarily in industrial and residential areas. Emergency services are accessed by calling the number '999', a holdover from its days as a British colony. The '999' number is available on a consistent basis to the entire Hong Kong population. Ambulances in Hong Kong contain all the equipment needed by paramedics in their duties. Every emergency ambulance has three on board personnel, at least one of which is an EMA II level paramedic. Hong Kong also uses ambulance-aid motorcycles in order to shorten arrival times for emergency care. The country also has four mobile casualty treatment centers which are there to respond to incidents in which there are many casualties (Graham, et al. [23]). Figure 4shows an ambulance that is heading towards Kwong Wa hospital in Hong Kong.

Figure 4: An ambulance heading towards Kwong Wa Hospital in Hong Kong

Hong Kong has both first responders and paramedics as part of its emergency medical system. In 2003, Hong Kong implemented a first responder program specifically focused on training firefighters. Fire crews with a first responder are generally dispatched when an ambulance is unlikely to arrive within the target response time. Paramedics in Hong Kong staff ambulance services and are divided by skill level into three categories. The first of these is EMA I, who attend 760 hours of lectures and practical training. They are trained in basic ambulance aid, the nitroglycerin protocol, and the respiratory protocol. EMA II paramedics are trained in caring for airways and intravenous cannulation as well as the use of automatic external defibrillators. They are also able to start IVs of saline and dextrose and provide intramuscular injections. Finally, they are able to dispense "sublingual nitroglycerin spray, and salbutamol and ipratropium by spacer device". In order to achieve this level, students participate in 234 hours of course and workshops and work for two weeks in hospitals. Recently, some senior EMAs have visited Canada in order to receive EMA III training (Graham, et al. [23]).

2.2.2 People's Republic of China

The People's Republic of China is a country in Eastern Asia with a population of 1,324,700,000 in 2008. Bordered by the East China Sea, South China Sea, Korea Bay, Yellow Sea, North Korea and Vietnam, its total area was 9,327,000 km^2 in 2008. Its major cities include its capital its capital, Beijing, Chongqing, Guangzhou, Shanghai, and Shenzhen. China is shown in green in Figure 5 below.

Figure 5: A map with the PRC highlighted in green (sans claimed territories)

China had a physician density of 1.42 per 1,000 people and has 4.2 hospital beds per 1,000 people. In 2008, its GDP was 4,521,800,000,000 US dollars. Its health expenditure was 5.1% of its GDP in 2012. China's industrialization and urbanization in recent decades has driven an increase in its sophistication of EMS. This sophistication has been driven by the Ministry of Health's creation of policies pertaining to pre-hospital care, beginning in 1980. China has developed an Emergency Medical Service System (EMSS) framework so that it works with the local healthcare system in China. The Chinese EMSS framework is divided into three parts: pre-hospital emergency service, emergency departments and the intensive care units. The pre-hospital emergency services consist of pre-hospital care and ambulance services. These are funded primarily by provincial and city bureaus of Public Health. This locally sourced method of funding often leads to more rural areas being unable to meet the Chinese regulatory standards

due to the costs for construction and equipment acquisition. Patients often pay out of pocket for emergency treatment and ambulance usage, although roughly 25% of the urban population has medical insurance (Hung, et al. [28]). The dispatch process for Emergency Medical Services is shown in Figure 6.

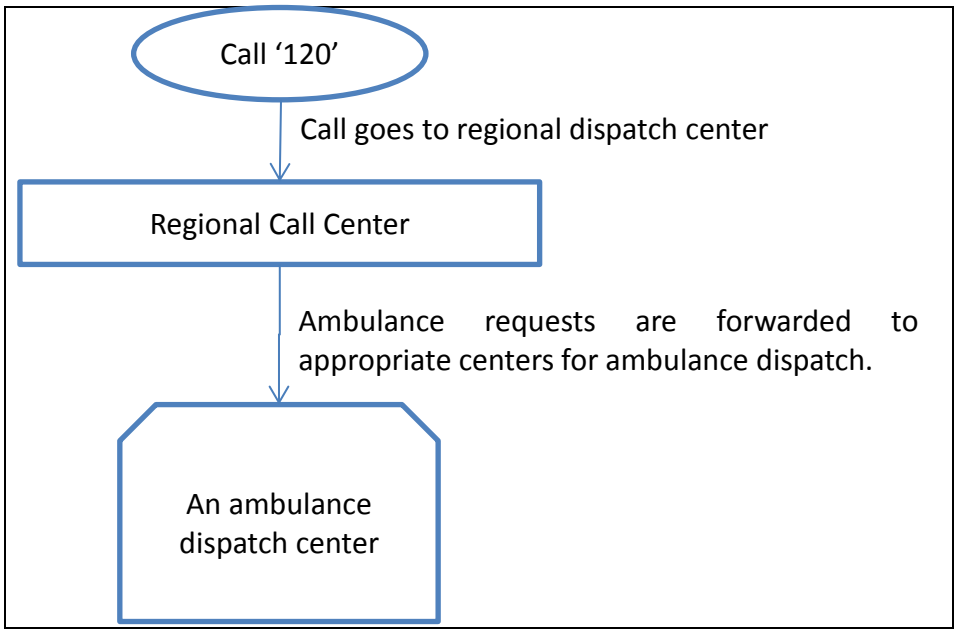

Figure 6: Dispatch Process Flowchart for People's Republic of China

Pre-hospital emergency services are accessed in China by dialing '120', but this system does not have an official method of implementation and is not available in more rural areas and smaller cities. Generally speaking, a regional call center will answer '120' calls when implemented, forwarding medical help requests to the appropriate ambulance dispatch center in the area (Hung, et al. [28]). An ambulance from the Shanghai Pudong Medical Emergency Center is shown in Figure 7.

Figure 7: An ambulance belonging to the Shanghai Pudong Medical Emergency Center

Most metropolitan cities in China have two types of ambulances. One type is a general ambulance and the other is an ambulance with additional equipment for monitoring patients and extra medication to help critically sick patients. Ambulances in China often use two-way radios for communication and GPS for enhanced navigation (Hung, et al. [28]).

China does not have a recognized paramedic profession. Instead, medical doctors, nurses, and drivers work in emergency service centers. Specialist training in pre-hospital care is not required to work in an emergency services center and the majority of doctors there do not have this specialist training. Pre-hospital emergency systems in China often have a shortage of staff which may be caused by differences in wages, training and recognition for their work compared to other doctors (Hung, et al. [28]).

2.2.3 Taiwan

Taiwan is a country located in Eastern Asia and had a population of 23 million in 2008. In the same year, its GDP was $400.2 billion. Taiwan covers an area of around 32 thousand km^2. Bordered by the East China Sea, the South China Sea, the Philippine Sea, and the Taiwan Strait,

it is located to the southeast of China and to the north of the Philippines. In Figure 8, Taiwan can be seen highlighted in green, to the east of China.

Figure 8: A map with Taiwan highlighted in green

Taiwan's population is unevenly distributed, with most of it residing within four cities. This uneven distribution has meant that rural areas have underdeveloped emergency medical services. A basic EMS system which was used for transportation of sick and injured patients was started in the 1960s and run by police stations. Communication with hospitals was substandard and the police stations were not trained in pre-hospital care. In 1990, the situation improved drastically, when a formal EMT training curriculum was created by people who had studied EMS in other countries. By 1995, Taiwanese EMS was being modernized through legislation with The Emergency Medical Service Act. Since the year 2000, Taiwan has rapidly developed and implemented many standards seen in modern EMS, such as paramedic training and the use of

automatic external defibrillators (Chiang, et al. [14]). A Taiwanese ambulance is shown in Figure 9.

Figure 9: An ambulance in Taiwan

The Taiwanese pre-hospital care system consists of both government and private services. The fire-based governmental services are staffed by all three levels of EMTs. Their primary responsibility is to transport patients to the hospital for free. Public ambulances are often funded by donations from Taoist and Buddhist temples. Private services charge patients and provide inter-hospital transport. They generally are only staffed by the first two levels of EMTs. In Taiwan, EMS dispatchers are firefighters. These dispatchers, however, receive no formal training or certification (Chiang, et al. [14]).

Taiwan has three levels of EMTs, each of which is similar to those in North America. Those trained to EMT-1 standards are able to measure vital signs, perform basic life support techniques and operate automatic external defibrillators. The EMT-2 level builds on EMT-1,

providing ECG monitoring, application of the laryngeal mask and pneumatic anti-shock garment, and some medications. Finally, EMT-P provides skills such as advanced airway management, advanced cardiac life support, trauma life support, pediatric advanced life support, disaster management and procedures for dealing with hazardous materials (Chiang, et al. [14]).

2.3 Europe

Europe geographically, is a peninsula. It's the second smallest continent worldwide, with an area of 10,790,000 km^2. Its population is the third largest containing more than 700,000,000 humans. This is fewer amounts of people than what China holds alone. Europe has been developing economically and culturally since the Paleolithic Era. It is interesting with the line of history how far the Europe's EMS models have developed. The European EMS models are known to incorporate modern tools, techniques and technologies such as telemedicine, electronic health records, pharmaceutical tracking systems and online communication into pre-hospital care or emergency medicine (see [42-43, 45-60]). This section examines the EMS systems in the following countries in Europe, Germany, Greece, Lithuania, Portugal, and United Kingdom.

2.3.1 Germany

Germany is a country in Central Europe. It's bordered by the Baltic Sea, the North Sea, Denmark, the Netherlands, and Poland. Germany's terrain contains lowlands in north, uplands in center, Bavarian Alps in south with a total area of 349,000 km^2. Germany is shown in green, residing in central Europe in Figure 10.

Figure 10: A map with Germany highlighted in green

Germany's population was 82.1 million in 2008. In 2008, Germany had a GDP of $3,623,700,000,000 US. The percentage of GDP spent on healthcare was 11.7% in 2012. The hospital bed density is 8.17 per 1,000 people while the physician density is 3.53 per 1,000 people. EMS in Germany started with Johann Friedrich von Esmarch's establishment of programs to educate people in first aid in the 19th century. By the end of the 19th century, Ernst von Bergmann had created a pre-hospital EMS in Berlin. In the early 20th century, the primary role of Germany EMS remained that of transporting patients. After World War II, the country was split into East and West Germany (Roessler, et al. [52]).

By 1960 in East Germany, a "Rapid Help" vehicle existed which brought an anesthetist to trauma patients. The "Urgent Medical Help" system was developed after 1966 in order to

respond to both trauma and medical emergencies. In 1976, the system became the “Rapid Medical Help” system. In East Germany, EMS directors were put in charge of areas with a population of over 80,000 people (Roessler, et al. [52]).

In West Germany, Karl Heinrich Bauer created the Clinomobil in 1957. This vehicle operated as a mobile operating room, but eventually was shown to be too rigid and costly. At the same time, Vicktor Hoffmann launched a similar system which operated on the basis of only treating injuries which were an immediate threat to the patient’s life. By 1974, national procedures and regulations for EMS were created. By 1989, national standards had been created and implemented for the training of emergency medical personnel. In 1990, reunification brought both East and West Germany back together. During this process, most of West Germany’s EMS practices replaced those in East Germany (Roessler, et al. [52]).

Ground based EMS in Germany is provided by local towns and municipalities. EMS is governed by legislation separately in each of Germany’s 16 Federal States. Since EMS is not entirely on the national level, this prevents EMS suggested practices in Germany from being entirely homogenous. However, emergency medical vehicles are generally expected to arrive at the scene within 15 minutes of a dispatcher receiving a call (Roessler, et al. [52]). The dispatch process for Emergency Medical Services is shown in Figure 11.

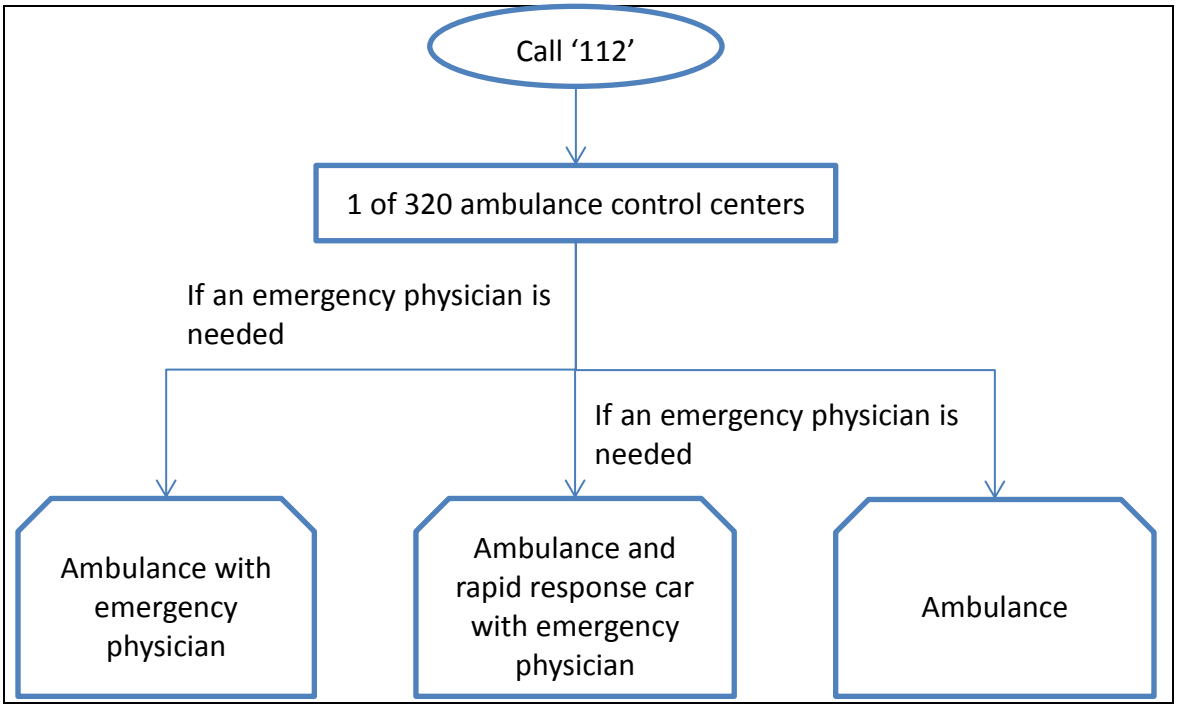

Figure 11: Dispatch Process Flowchart for Germany

In Germany, EMS, alongside fire and police, may be accessed by calling the '112' phone number. This call is received by one of 320 ambulance control centers and answered by a paramedic with supplemental training for ambulance dispatch. The paramedic dispatches either an ambulance or a vehicle staffed with an emergency physician depending on input from the caller (Roessler, et al. [52]).

If an emergency physician is needed at the scene, he or she uses one of two systems for transportation. The rendezvous system has the physician take a vehicle designated for rapid response with the necessary supplies to meet an ambulance at the scene. While this vehicle does not have the ability to transport the patient, it allows the physician to move onto another call sooner, provided the physician does not have to accompany the patient to the hospital. In

the stationary system, the physician travels with the ambulance (Roessler, et al. [52]). Figure 12 shows a typical German ambulance at a soccer field.

Figure 12: An ambulance at a German soccer field

German EMTs are divided into three levels. These levels are “Rettungshelfer”, “Rettungssanitäter” and “Rettungsassistent”. Rettungshelfer are required to participate in 160 hours of classroom training and 80 hours of hospital-based training. Their training primarily covers general emergency medicine and resuscitation and they don’t participate in emergency transport. Rettungssanitäter train for an additional 80 hours in the hospital and 160 hours in an ambulance. The highest level of training, Rettungassistent, was created in 1989. It requires

1200 hours of practical and theoretical training, followed by 1600 hours of apprenticeship in an ambulance service (Roessler, et al. [52]).

In Germany, most emergency ambulances are required to have at least one Rettungssanitäter and one Rettungsassistent. It is preferred that interventions are performed by emergency physicians over EMTs. However, EMTs are allowed to perform certain interventions if a physician is not available. These interventions are the administration of some drugs, defibrillation, the infusion of crystalloid solutions, and intubation. All other interventions are provided by emergency physicians (Roessler, et al. [52]).

2.3.2 Greece

After Greece achieved independence from the Ottoman Empire in 1829, it gradually began adding nearby islands and territories. Today Greece is bordered by the Aegean Sea, Ionian Sea, Mediterranean Sea, Albania and Turkey, with a total area of 129 thousand km^2. Figure 13 highlights Greece in green to show its location in southern Europe.

Figure 13: A map showing Greece's location

The GDP of Greece was at $341.2 billion in 2008. In the same year, its population consisted of 11.2 million people. In 2009, a Greek citizen has a life expectancy of 80 years at birth. There were also 6.17 physicians per 1,000 people in that year in Greece.

The types of ambulance cars are used for emergency transport and also for comfort. The EMS in Greece is known as Ethniko Kentro Amese Boitheias (EKAB), which is completely funded by the government. Greek emergency medical services are free for all citizens due to funding from the Greek National Health Care System (Papaspyrou, et al. [47]).

EMS began in Greece with the creation of a first aid station in 1915 in Athens. This first aid station was funded by the Savior charity. The Hellenic Red Cross created a three more first aid stations between 1932 and 1988. These first aid stations were each equipped with

ambulances. Four more ambulance equipped first aid stations were created by the Social Insurance Institute in 1965. By 1975, Athens General Hospital founded the Center for Emergency Care. Eventually, resources from the Red Cross and Social Insurance Institute were merged into the Center for Emergency Care in 1986. This process also established '166' as the national telephone number for EMS in Greece. In 1987, the National Center for Emergency Care (Ethniko Kentro Amesis Boitheias) was created by the Greek government under the Ministry of Health with the purpose of handling Greece's EMS (Papaspyrou, et al. [47]).

Today, Greek EMS is handled by the National Center for Emergency Care (EKAB). EMS in managed via 12 EKAB stations in the major Greek cities. EKAB substations operate under the authority of an EKAB station in order to serve a larger area. Dedicated communications and dispatch centers, physicians, EMTs and emergency medical equipment are at each station. EKAB stations coordinate with health care centers and hospitals in their respective regions for ambulance dispatch. These local health care centers and hospitals have their own equipment and personnel (Papaspyrou, et al. [47]). The Greek dispatch process for Emergency Medical Services is shown in Figure 14.

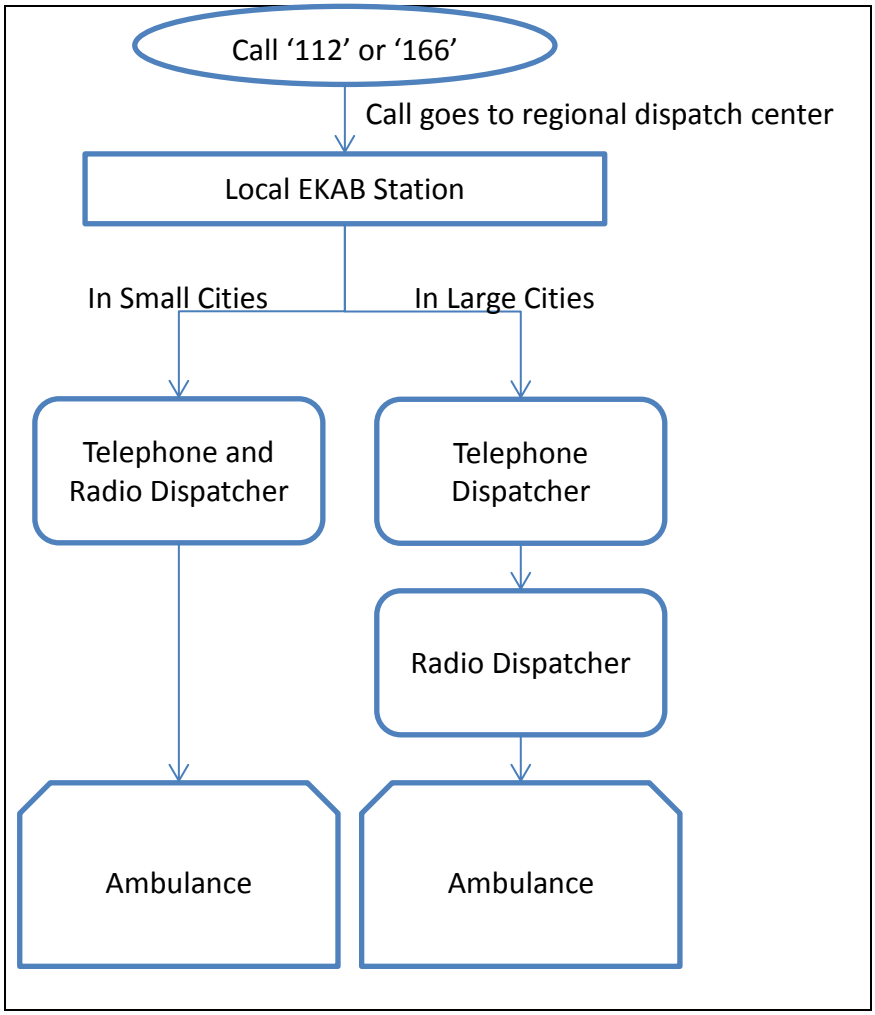

Figure 14: Dispatch Process Flowchart for Greece

Emergency Medical Services in Greece are accessed via either the '112' or '166' telephone numbers (Papaspyrou, et al. [47]). After calling the number, the caller is connected to a dispatcher which handles phone calls. In smaller cities, this dispatcher will also communicate with ambulances over radio. In large cities, separate dispatchers handle radio communication. All dispatchers are trained EMTs with additional training for dispatch (Papaspyrou, et al. [47]).

Greece has two types of land ambulances: basic ambulances, and Mobile Intensive Care Units (MICU). Basic ambulances are equipped with first aid equipment, intravenous access kits, oxygen, simple airway equipment and suction. MICUs are equipped with advanced airway equipment, fluids, intravenous access equipment, manual defibrillators, pulse oximeters, drugs and ventilators. Some Greek cities also have motorcycles staffed with a paramedic and (optionally) a physician (Papaspyrou, et al. [47]).

In Greece, there are two levels of EMTs: basic EMTs and advanced EMTs. Basic EMTs attend 1000 hours of training on topics such as assessing the critically ill, basic airway management, basic life support, cardiopulmonary resuscitation, immobilization of fractures, safe transportation, triage and treatment and wound management. Advanced EMTs attend 1400 hours of training, 800 hours of which is spent on theory and 600 hours of which is spent on workshops and practical training. Advanced EMTs learn about advanced life support, anatomy, common emergencies, disaster management, ECG-monitoring and manual defibrillation, infectious diseases, intravenous access techniques, pharmacology, physiology, and treatment protocols in addition to subjects covered by basic EMT training (Papaspyrou, et al. [47]).

2.3.3 Lithuania

The Republic of Lithuania is a small country in Eastern Europe with a population of 3.4 million people in 2008; roughly 70% of which live in urban areas. The capital of Lithuania is called Vilnius. The country is bordered by the Baltic Sea, Latvia, and Russia, occupying a total area of around 63,000 km^2. Figure 15 shows Lithuania, highlighted in green, in Eastern Europe.

Figure 15: A map of the location of Lithuania

In 2008, Lithuania's GDP was $47.3 billion. In 2009, Lithuanians could expect to live to be 73 years of age at birth. In the same year, there were 3.61 physicians for every 1,000 people in the country.

Lithuania's Health care system is divided into three political and administrative levels: National Health, County Health, and Municipal Health. Its emergency care is free which is financed from Compulsory Health Insurance Fund and by the government (for citizens without health insurance). These medical funds are collected by general taxation (Vaitkaitis [59]).

The Vilnius Society of Ambulances was established in 1899 with the goal of providing free emergency aid to the people in and around Vilnius. Financed by charity, this ambulance service established its first ambulance station in 1902. In 1909, the Red Cross Hospital provided

the first ambulance carriage in the city of Kaunas. By 1937, the Kaunas Ambulance Station was founded. During Soviet rule, ambulance services became specialized and, in cities, commonly staffed physicians with certain specialties. However, rural ambulance services generally only employed feldshers, which were nurse who were trained to perform various medical procedures. From 1990 onward, ambulance services have become less specialized. Currently, healthcare policy in Lithuania is managed by the Ministry of Health (Vaitkaitis [59]).

The Compulsory Health Insurance Fund (CHIF) and the government finance emergency care in Lithuania. The CHIF is responsible for 90% of the money spent on healthcare. Modern Lithuanian ambulance services rely on ground ambulances for transportation of patients to the hospital (Vaitkaitis [59]). Lithuania lacks standards for ambulance service, although bigger cities attempt to address this issue by having physicians in their ambulances (Vaitkaitis [59]).

The dispatch system for ambulance services is decentralized, with each ambulance center having its own dispatcher available 24 hours a day. Experienced nurses advise patients and decide whether or not to dispatch an ambulance. Ambulance services are reached via two phone numbers: the '03' ambulance services number and the '112' common access number. Ambulances generally have a crew of two to three people. The clinical staff on the crew consists of nurses and physicians. Ambulance services in cities generally staff specialist physicians in their ambulances while rural ambulance services generally only staff nurses (Vaitkaitis [59]).

In Lithuania, all drivers' license applicants in Lithuania have to pass 12 hours of first aid training and all firefighters, rescuers, police officers, and military personnel have to attend 18 hours of said training (Vaitkaitis [59]). All medical schools in Lithuania include basic emergency

procedures as compulsory training for students and basic and advanced life support supplemental training is available. Plans are in place to introduce paramedics in ambulance services in Lithuania (Vaitkaitis [59]).

2.3.4 Portugal

The Portuguese Republic is a country in Southwestern Europe with a population of around 10.6 million in 2008. It's mostly mountainous in the north of the Tagus River, and is bordered by the Atlantic Ocean and Spain, with a total area of around 91 thousand km^2. Figure 16 identifies Portugal in green and it is located to the west of Spain.

Figure 16: A map with Portugal highlighted

In 2008, Portugal's GDP was $251.9 billion. In 2009, Portuguese citizens could expect to live to the age of 79 at birth. In 2010, there were 3.87 physicians per 1,000 people in Portugal.

Portugal's first EMS system was created in 1965 in Lisbon. Its objective was to transport patients to the hospital. This first service was accessed by calling the '115' telephone number and ambulances were staffed mostly with police officers. In 1971, the National Ambulance Service was created with the goal of providing EMS across Portugal. During 1980, the National Institute for Emergency Medicine was created under the Ministry of Health and given responsibility over EMS. By 1987, Lisbon had the first EMS dispatch center. Finally, in 1989, ALS was able to be provided by physicians in an emergency medical vehicle (Gomes, et al. [21]). Figure 17 shows Portugal's dispatch process for Emergency Medical Services.

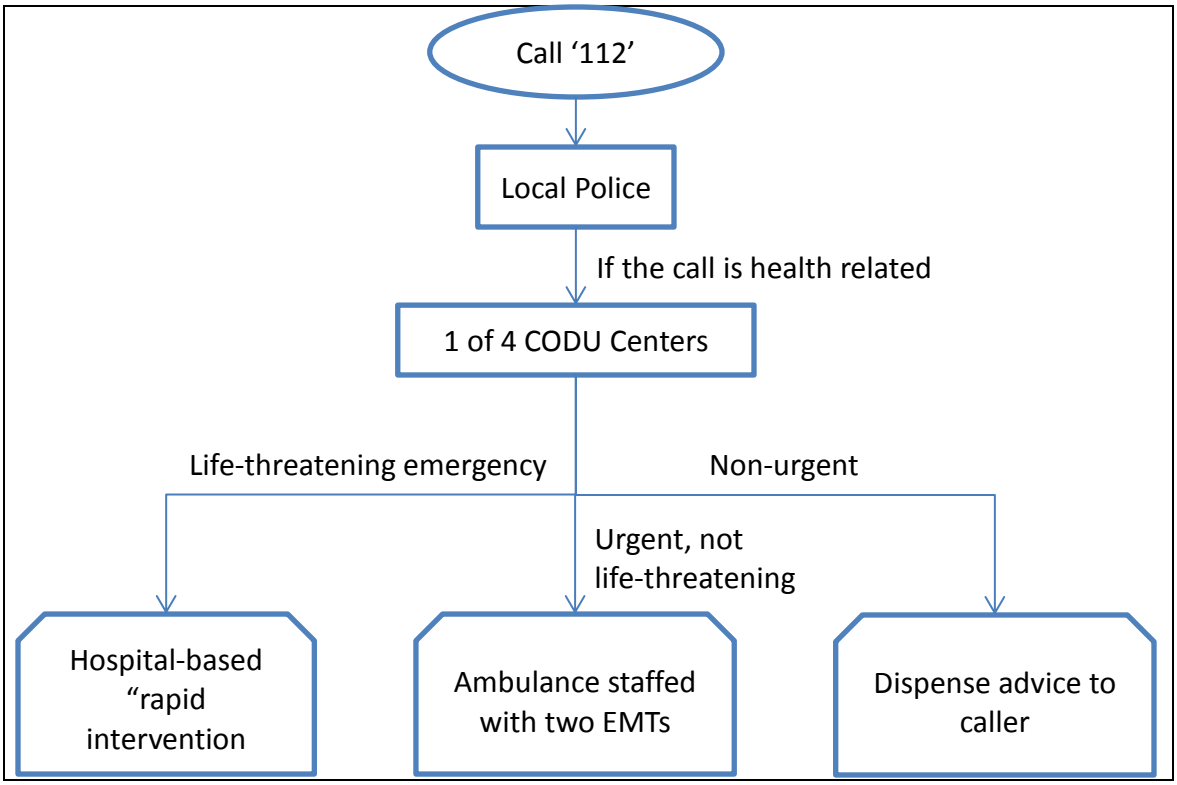

Figure 17: Dispatch Process Flowchart for Portugal

In Portugal, '112' is called in order to access Emergency Medical Services. The police answer and transfer the call to one of four Centro de Orientação de Doentes Urgentes (CODU)

centers, if it is related to health. There, a dispatcher, supervised by a doctor, fills out a questionnaire. As illustrated in Figure 16, depending on the situation, the dispatcher will either give advice, or if urgent, will dispatch an emergency vehicle. If the situation is life threatening, a doctor and nurse will accompany the vehicle as opposed to two EMTs. The dispatch center will also call the receiving emergency department to relay clinical information regarding the patient (Gomes, et al. [21]). Dispatchers are able to receive 210 hours of training for their job and supervising doctors can receive 40 hours of training (Gomes, et al. [21]).

EMS workers are divided into three levels in Portugal. The first is the basic first responder, typically police officers and firefighters. A basic first responder under goes roughly 40 hours of training in basic first-aid and basic life support. The second level consists of ambulance technicians, who staff ambulances. After 210 hours of training, they are capable of basic life support, basic wound management, oxygen administration, patient extrication, patient transfer, spine and fracture immobilization and uncomplicated obstetric delivery. The final level is a medical team consisting of a doctor and a nurse. Both doctors and nurses undergo 74 hours of additional training in advanced life support, pediatric advanced life support, and trauma life support. Nurses, however, receive 40 hours of driving instruction on top of that (Gomes, et al. [21]).

2.3.5 United Kingdom

The United Kingdom is a country in Western Europe consisting of a group of islands to the northwest of France and bordered by the North Atlantic Ocean and the North Sea. Its total area is 243,610 km^2 which it makes it somewhat smaller than the state of Oregon. From the

total population, which it will be discussed further in this section, 80% lived in urban areas in the year of 2010. Its major cities include Birmingham, Glasgow, its capital London, Manchester, and West Yorkshire. The United Kingdom has a very unique weather that is common on the European countries. The days in the United Kingdom are usually overcast, cloudy and gray more than half of the day. As shown in green in Figure 18, United Kingdom is located off the north-western coast of the continent of Europe and no location within the United Kingdom is greater than 125 km from the ocean.

Figure 18: A map showing the location of the United Kingdom

The United Kingdom has the third largest GDP in Europe and the seventh largest national economy in the world measured by the nominal GDP. United Kingdom's GDP is $2.228 trillion, however only a 9.3% of the GDP is spent in healthcare. The physician density is 2.74 per 1,000 people and the hospital bed density is 3.3 per 1,000 people.

Emergency Medical Services in the UK are accessed by calling either ‘112’ or ‘999’. The call is connected to a dispatcher at one of 38 National Health Service ambulance stations. After the location of the patient is received, an ambulance is dispatched. Further information about the patient is relayed over the radio or electronically to the ambulance (Black, et al. [6]). Figure 19 is a flowchart depicting the dispatch process for UK Emergency Medical Services.

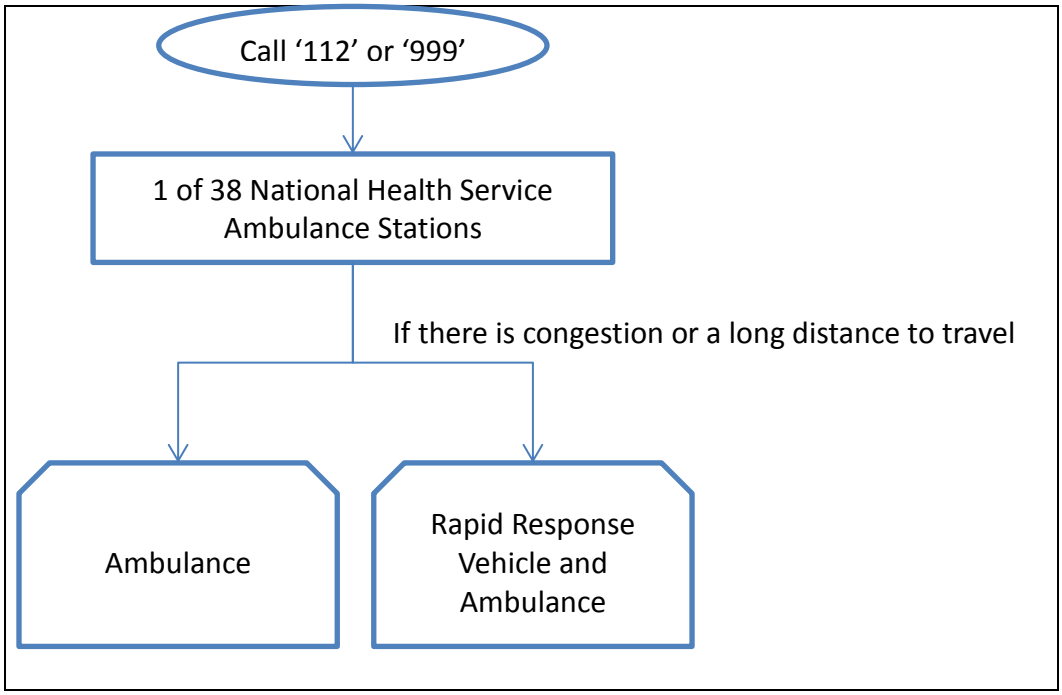

Figure 19: Dispatch Process Flowchart for United Kingdom

There are two ground based vehicles used in the United Kingdom for responding to emergency calls. The first of these is an ambulance. Ambulances are normally crewed by a paramedic and an ambulance technician. The second of these vehicles is a rapid response vehicle. Rapid response vehicles are motorcycles staffed with either a paramedic or ambulance technician. These vehicles are sent ahead of ambulances in situations where the route is

congested or, in rural areas, where the route is fairly long (Black, et al. [6]). An ambulance belonging to the South Western Ambulance Service is shown in Figure 20.

Figure 20: An ambulance belonging to South Western Ambulance Service

Training programs for Emergency Medical Technicians in the United Kingdom are not entirely uniform. These programs do, however, center on content created by the Institute of Health and Care Development (IHCD). EMTs are required to administer care according to

standards created in part by the Joint Royal Colleges Ambulance Liaison Committee (Black, et al. [6]).

There are two types of EMTs in the UK. These are ambulance technicians and paramedics. Only after spending 1 year under the supervision of an EMT and completing an IHCD formal exam, are ambulance technicians allowed to operate independently. Ambulance technicians with at least 1 year of experience in the field (as a full ambulance technician) are able to train as a paramedic if recommended by their employer. Paramedic candidates train for two months in anatomy and physiology, trauma care management as well as various medical emergencies. Additional time is spent receiving training in advanced cardiac life support. Before becoming certified, paramedics spend 6 months participating in work-based assessments (Black, et al. [6]).

2.4 Middle East

Emergency Medical Services in the Middle East are influenced by geography, economy, political boundaries and population density. Pre-hospital care or emergency medicine varies immensely across in the Middle East. Some countries use the Anglo-American EMS model while others use the Franco-German model.

2.4.1 Sultanate of Oman

The Sultanate of Oman (capital, Muscat) is located in the Middle East on the southeastern coast of the Arabian Peninsula. It is bordered by the Arabian Sea, the Gulf of Oman, the Persian Gulf, Yemen, and the United Arab Emirates, with total area of 309,500 km^2.

Its geographical features consist of central desert plain and rugged mountains in the north and south. The Sultanate of Oman is highlighted in green in Figure 21.

Figure 21: A map showing the Sultanate of Oman

It is well known that most Middle Eastern countries contain large amounts of petroleum. A Survey taken in 2006 indicates that Sultanate of Oman has a population 2.577 million, with only 1.844 million are citizens. Of its population, 73% lived in urban areas in 2010. In 2009, Oman's Gross Domestic Product (GDP) was 74.46 billion, with 3% of it going towards healthcare expenses. This expenditure is in part reflected by the physician density and the hospital bed density. Oman has a physician density of 1.90 per 1,000 people and a bed density 1.90 per 1,000 people. Various other statistics such as the death rate, the infant mortality rate and HIV/AIDS prevalence rate are interesting aspects to consider when taking a closer look at Sultanate of Oman's EMS system.

The Joint Royal Oman Police and Ministry of Health committee for "the development of a modern EMS system" was formed in 2000. A group of physicians and nurses were sent to the United States in order to receive training as instructors in emergency medicine in 2001. This group would be tasked with devising a training program for "advanced emergency medical care" and creating EMS standards in Oman. In 2004, the Omani ambulance service was launched with a focus on responding to traffic accidents (Al-Shaqsi [2]).

In Oman, the EMS system is funded by the government via the Royal Oman Police and is available free of charge. The service may be accessed by dialing the national '9999' emergency phone number (Al-Shaqsi [2]). A centralized call center communicates with local ambulance services in order to dispatch ambulances. An ambulance is staffed with two Advanced Emergency Medical Technicians (AEMT) and a driver with training in ambulance driving and first aid. AEMTs have available to them a system for consulting experienced professionals for advice if needed (Al-Shaqsi [2]).

Omani education in EMS is provided by instructors who are affiliated with and licensed by international EMS associations. Advanced Emergency Medical Technicians are trained in Basic Life Support, Advanced Cardiac Life Support, Basic Trauma Life Support, Pre-Hospital Trauma Life Support, Pediatric Advanced Life Support, as well as other areas. Much of the training program for AEMTs was adopted from the NHTSA in the US (Al-Shaqsi [2]).

2.5 North America

North America is the third largest continent in the world, following Asia, and Africa. Its area is 24,256,000 km^2. In 2010, its total population was approximately 528,000,000. North

Americas was relatively a recent discovery, and was named after the explorer Americo Vespucci. It contains the World's shortest river which is only 61 meters long, known as The Roe River, located near the Great Falls, Montana, USA. North America covers 23 countries, in which only the largest two, The United States, and Canada will be examined discussing their EMS systems.

2.5.1 Canada

Canada is the second largest country in the world after Russia with an approximately 3,854,085 square kilometers which is somewhat larger than United States. It is located in the northern region of North America as shown in the image below. In addition, an approximately 90% of the population lives in a narrow strip of land of Canada's southern border with the U.S. Canada is highlighted in green in Figure 22.

Figure 22: A map with Canada highlighted in green

Canada's environment is currently facing issues such as air pollution, affected lakes due to the acid rain, and ocean waters becoming contaminated due to all the industrial and mining activities among other issues. Although these could become environmental issues, like industrial activities, for Canada they are part of the industry which is makes 27.1% of its GDP. Transportation equipment, chemicals, processed minerals food products, petroleum and others are also part of the industry. Canada has a great industrial society. It has growth over the years in manufacturing and mining. Agriculture only composes 1.9% of the GDP in Canada. On the other hand, the most GDP comes from services with a 71% since is the US's largest foreign supplier of energy, including oil, gas, and electric power.

Canada had a population of 34,300,083 in 2012. Canada has a birth rate of 10.28 per 1,000 people and a death rate of 8.09% per 1,000 people.

EMS in Canada operates against the background of a universal health insurance plan, commonly known as Medicare, legislated through the Canada Health Act. Even though medical care is publicly administered, EMS delivery is not. Within Canada's 13 EMS systems, every funding and service delivery model, except a fully private model, is represented (Symons, et al. [54]).

Service delivery models range from a fully provincially run service, to regionally or municipally run services, to municipally or regionally contracted services. Some services are "free-standing", some are based in fire departments, while others are hospital-based. Most of the nation's EMS services are publicly-operated or publicly contracted. In a minority of jurisdictions there is a mix of publicly and privately run services. All of urban and much of rural Canada is able to contact emergency services, police, fire or ambulance, by dialing 911 (Symons, et al. [54]).

Service delivery models range from a fully provincially run service, to regionally or municipally run services, to municipally or regionally contracted services. Some services are based in fire departments some are hospital-based, while others exist on their own. Most of the nation's EMS services are publicly-operated or publicly-contracted. In a minority of jurisdictions there is a mix of publicly and privately run services (Symons, et al. [54]).

The Canadian Medical Association has replaced its outdated system of provider classification (paramedic level I, II, III) with the new NOCP levels of primary care paramedic

(PCP), advanced care paramedic (ACP) and critical care paramedic (CCP). It has not adopted the lowest level classification, known as the emergency medical responder (EMR), even though courses for it are common in most provinces, especially in more remote areas. The only requirements common to all EMS systems are the appropriate provincial driver's license and CPR training (Symons, et al. [54]).

EMRs may be the primary responders in rural areas. They have basic qualifications (e.g. provincial driver's license), and are equipped with simple basic life support skills such as CPR with oxygen, oropharyngeal airway (OPA) insertion and bagvalve mask (BVM) ventilation as well as spinal immobilization equipment. Some EMR services are equipped with semi-automated external defibrillators (AED). EMRs do not perform any invasive interventions nor do they maintain IVs or give medications (Symons, et al. [54]).

PCPs are skilled in simple invasive procedures such as blood glucose monitoring and IV access. They are trained to administer a limited number of medications. PCPs also provide cardiac monitoring using 3-lead configurations and are trained in the use of AEDs. Manual defibrillation is not part of the PCP's skill set. Basic airway management skills include OPA and BVM ventilation. ACPs undertake an in-depth study of injury and of disease processes as well as learning advanced interventions, they can administer all. CCPs build on the ACP education and training. In addition to the ACP skills, they are trained in recording 12-lead ECG's. CCPs are also trained to interpret lab results and X-ray results (chest, back and cervical spine) (Symons, et al. [54]).

2.5.2 United States of America

The United States of America is a country in North America with a population of 313,847,465. As shown on image below, it is located bordered by the Atlantic Ocean, the Pacific Ocean between Canada and Mexico. United States total area is of about 9,826,675 km^2 about the half of the size of Russia. From its population, 82% lived in urban areas in 2010. Its major cities include Chicago, Los Angeles, Miami, New York, and its capital, Washington, D.C.. The USA is highlighted in green in Figure 23.

Figure 23: The location of the United States of America

The first successful system for treating and transporting injured soldiers in the United States was adapted by General Jonathan Letterman, a Union military surgeon, during the Civil War. Due to his success, the civilian sector began to introduce its own emergency medical

systems soon after. The first civilian ambulance service was created by the Commercial Hospital of Cincinnati in 1865 (Pozner, et al. [49]).

While military EMS advanced greatly during World War I and World War II, it wasn't until the 1950s that these advances made their way into the civilian sector. At this time, Sam Banks and JD Farrington created a first-aid training program which became the basis for the first emergency medical technician training programs in the United States. During the 1960s, there were two models for advanced care in the US. One used paramedics, while the other was reliant on physicians and nurses and was designed for patients having heart attacks. In 1966, the National Academy of Sciences released a paper outlining the inadequacies of EMS in the United States and suggested 24 ways to improve it. Later, California passed the Wedworth Townsend Act of 1970, allowing paramedics to act as surrogates for physicians under the direction of off-site physicians. After 1973, millions of dollars were allocated for EMS training, equipment, and research by the US government. Eventually, this burst of funding came to an end in 1981, when the US passed the Omnibus Budget Reconciliation Act, moving away from grants for individual purposes, such as EMS, and towards block grants, allowing states to allocate funds as they deemed appropriate (Pozner, et al. [49]).

Emergency medical systems in the United States exist as both government supported and privately supported systems. Governmental EMS is generally based around fire departments, but may be based around police or even as a separate entity in large counties or cities. Often times, private EMS will be partnered with a municipal service, providing some or all of some of the pre-hospital care. Hospitals sometimes have their own emergency medical

services. In much of the US first responders are often local police or firefighters (Pozner, et al. [49]). Figure 24 shows an ambulance used by Boston EMS inside the service garage.

Figure 24: An ambulance used by Boston EMS

In the United States, the number '911' is used to reach EMS, the fire department, and police. The majority of the US has the '911' number available, and many now have an enhanced system which provides the caller's location to the dispatcher. Some places still do not have a '911' number available, and require different phone numbers to be called for each service. In

the US, formal training is available for EMS dispatchers, but is not necessary in every state (Pozner, et al. [49]).

Emergency medical technicians in the US have five levels of education. These are the first responder, the basic EMT, the intermediate EMT, the paramedic, and the pre-hospital critical-care provider. First responders are knowledgeable in basic first aid, basic wound management, cardiopulmonary resuscitation, fracture immobilization, and uncomplicated obstetric delivery. It takes between 40 and 50 hours of training to become a first responder (Pozner, et al. [49]).

Basic emergency medical technicians are trained in oxygen administration, patient extrication, patient transfer, and scene triage, as well as the training that first responders receive. The training program to get to this level lasts 110 hours. There also exists optional training in advanced airway management (Pozner, et al. [49]).

Intermediate emergency medical technician training programs vary from state to state. The curriculum varies, but intermediate EMTs may be knowledgeable of cardiac monitoring, initiating intravenous lines, manual defibrillation, and performing tracheal intubation (Pozner, et al. [49]). Paramedics usually attend programs exceeding 1000 hours in length and consisting of between 250 and 500 hours of classroom training and another 250 to 500 hours of hospital-based clinical training. New paramedics are required to be mentored by experienced paramedics through internships. Graduates are capable of administering some medications, advanced airway management techniques, advanced interventions, cardiac monitoring, manual defibrillation, and needle thoracostomy (Pozner, et al. [49]).

CHAPTER 3. EMS IN SELECTED CITIES OF THE UNITED STATES

3. Introduction

Emergency Medical Services in the United States follow the Anglo-American model of EMS. However, EMS is not entirely uniform throughout the jurisdictions of the United States, and the same is true in other countries. In the US, budgets, funding, training levels and organizational structures and functions differ by jurisdiction. In this chapter, an examination of these areas and others across Boston EMS, the FDNY and King County EMS, which services Seattle, is performed.

3.1 Boston EMS

Boston, Massachusetts is one of the nation's oldest cities. Its Emergency Medical Service have been providers of pre-hospital care over a century ago; in fact they been having saving lives since 1877 according to Boston's annual report (Boston EMS [7]). In addition to its rich history, Boston is the 22nd largest city in the United States.

A large city with such "diversity, historical significance and designation" as Boston, Massachusetts' capital, its population stretches to approximately 900,000 people during work day (Boston EMS [7]).

Out of all the EMS systems in the United States, Boston EMS is one of the busiest and largest. As Boston's EMS goes through over 100,000 emergency medical calls each year, 350 Emergency Medical Technicians (EMTs) experience exciting, and busy days at work. The Service Area Overview is from Boston's Annual Report, which illustrates a general view of Boston (Boston EMS [7]). In Table 1, data regarding Boston EMS' service area is shown. This

information includes the daytime population, the resident population and the types of EMS provided.

Table 1: Boston EMS Service Area Information

Service Area Information	
Area Served	The City of Boston
Boston Land Area	45.7 mi^2
Resident Population	617,594
Daytime Population	~900,000
Residents Living Below Poverty Line	19%
2010 Homeless Population	7,286
Residents Who Report Speaking a Language Other than English at Home	34%
EMS Services Provided	• ALS (Advanced Life Support) • BLS (Basic Life Support)

The two types of support Boston EMS offers, is BLS which might not be the crucial emergency support response, and there is the ALS, which services and leverages the latest advances in both medicine and technology according to Boston EMS' Annual Report. The indications of transports versus clinical incidents are displayed in Figure 25, with Figure 26 displaying the Ratio of Transports per Clinical Incidents relatively increasing throughout the years (Boston EMS [7]).

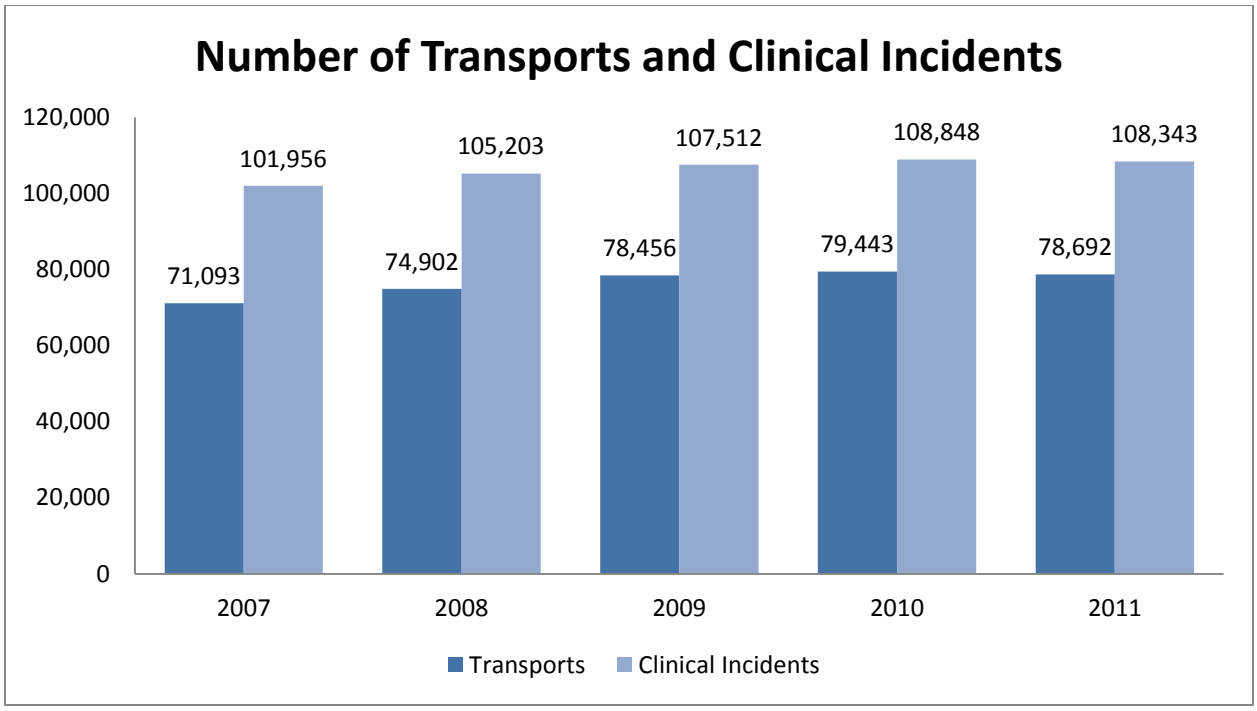

Figure 25: Number of Transport and Clinical Incidents

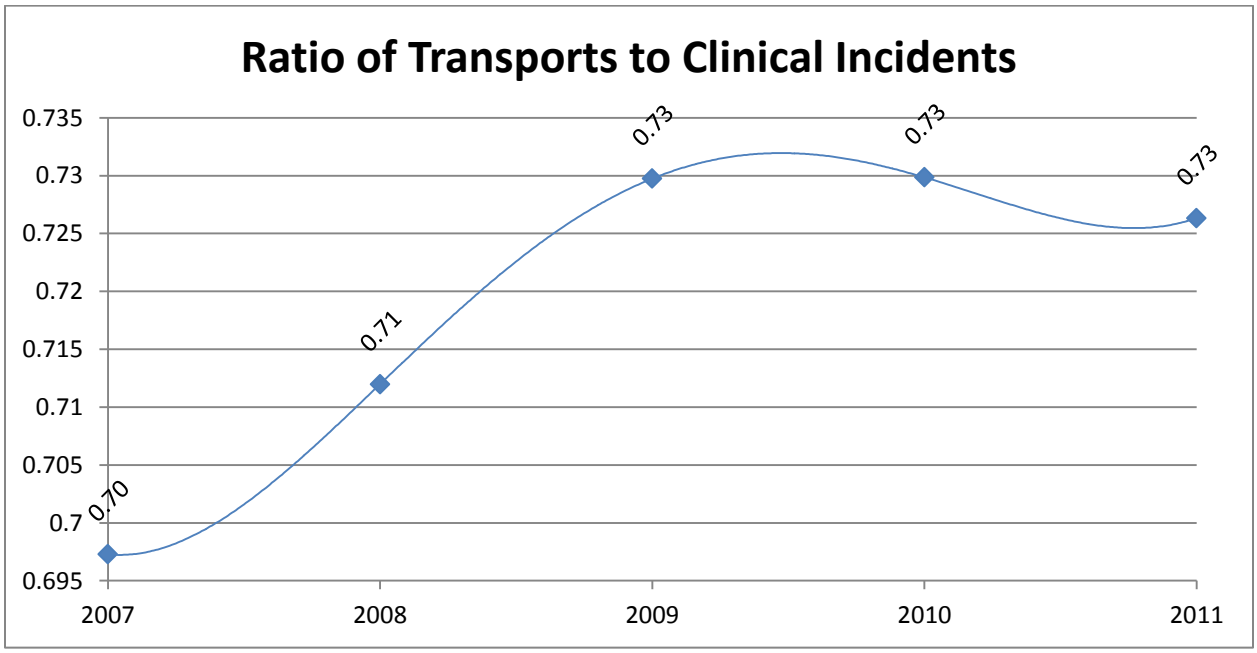

Figure 26: Ratio of Transports to Clinical Incidents

3.1.1 2011 Statistics for Boston EMS

The Boston EMS Department's main focus is to provide excellent pre-hospital care. Boston EMS systematically monitors and analyzes important operational and clinical

performance data such call volume, patient satisfaction results, response times, and various patient outcome measures, and others, to make considered decisions (Boston EMS [7]).

The following tables and graphs were developed by Boston EMS in order to show different statistics from the year 2011. Table 2 describes the number and percentage of incidents divided by type (Boston EMS [7]).

Table 2: Incidents by Type

Incidents By Type	Number	Percentage
Illness (abdominal pain, fever, etc.)	31,181	29%
Investigations ("man down", alarm, etc.)	20,458	19%
Injury (lacerations, fractures, etc.)	15,587	14%
Cardiac Related (unconscious, CPR, etc.)	11,135	10%
Respiratory (asthma, CHF, etc.)	8,702	8%
Psychological/ Suicidal	6,777	6%
Motor Vehicle (MVA, pedestrian, cyclist struck, etc.)	5,711	5%
Neurological (CVA, seizures, etc.)	4,520	4%
Fire/ Hazmat/ Standby/ Environ.	2,014	2%
Trauma (penetrating injury, long fall, etc.)	1,289	1%
Overdose	969	<1%
Total	**108,343**	**100%**

Table 3 displays the number of incidents in the various regions around Boston. The highest percentage of incidents occurs within Dorchester North, Roxbury and the South End. The lowest percentages of incidents are in Long Island and Charlestown (Boston EMS [7]).

Table 3: 2011 Incidents by Neighborhood

Incidents by Neighborhood	Number	Percentage
Allston/ Brighton	6,395	6%
Back Bay	8,610	8%
Beacon Hill/ West End	2,944	3%
North End	3,754	3%
Charlestown	2,185	2%

East Boston	6,788	6%
South Boston	5,899	5%
South End	12,412	11%
Roxbury	15,936	15%
Dorchester North	16,310	15%
Dorchester South	7,543	7%
Roslindale	4,138	4%
Jamaica Plain	3,225	3%
West Roxbury	2,838	3%
Hyde Park	4,763	4%
Mattapan	3,419	3%
Long Island	415	<1%
Other/Not Listed	769	1%
2011 Total	**108,343**	**100%**

Figure 27 displays the number of people transported percentage-wise, broken up into different age demographics. The largest of these groups is those people between age 45 and age 65. The smallest group is that of people under 15 years of age (Boston EMS [7]).

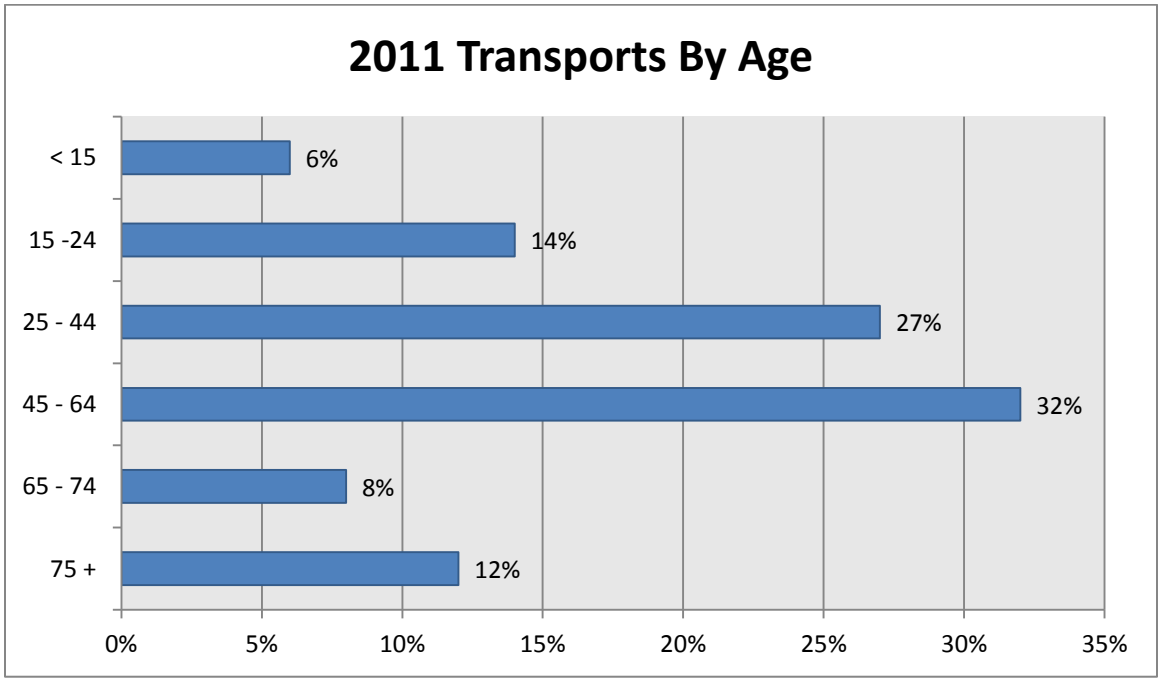

Figure 27: 2011 Transports by Age

Boston EMS is one of the busiest EMS systems in the country, responding to an average of 300 calls per day. Thus, as one of the busiest EMS, they have established response time goals. The arrival time for the responses varies according to the priority of the call. There are three different priority calls. The first of these is the Priority 1 call, which involves urgent or life threatening situations. The second is the Priority 2 call. This call is used when a situation is either serious or potentially life threatening. Priority 3 and 4 calls are for non-life threatening illnesses or injuries (Boston EMS [7]).

The response time's goals that Boston EMS targeted and achieved are shown in Table 4. These serve as an indicator of how well an EMS system is meeting its own goals as well as how ambitious its goals are (Boston EMS [7]).

Table 4: 2011 Median Response Times

2011 MEDIAN RESPONSE TIMES		
Priority Level	**2011**	**Goal**
Priority 1	5.7 minutes	6.0 minutes
Priority 2	7.3 minutes	7.0 minutes
Priority 3	7.6 minutes	8.0 minutes

As mentioned before, Boston EMS takes into account the patients input. They take feedback from the patients to improve any areas as needed. The way Boston EMS manages to take feedback is giving surveys to the patient. Statistics have shown that only 7% of the patients take the survey, but 95% of the respondents felt that Boston EMS has an excellent service (Boston EMS [7]).

Boston EMS has different income streams such as funds from commercial insurance providers, Medicaid, Medicare, private payers, grants, and others. During 2011, roughly 76% of income came from billing insurance (Boston EMS [7]).

3.1.2 Clinical Innovation

Boston EMS' improvement of pre-hospital care centers on the work of its Research, Training, and Quality Improvement (RTQI) team. This team is comprised of EMTs, Paramedics, Training Officers, and physicians from the emergency department. The RTQI team researches topics such as the best practices for cardiac resuscitation, alternative intravenous access device efficacy, and the efficacy of new types of breathing equipment (Boston EMS [7]).

Boston EMS has been participating in the Massachusetts Department of Public Health's EMS Stroke Quality Improvement Initiative in recent years. This involved the participation of RTQI team members in various meetings revolving around improving the care for stroke patients. In 2011, Boston EMS was able to improve pre-hospital stroke patient care via its "stroke quality improvement and management program". This program involved the RTQWI team reviewing the records of stroke and potential stroke patients on a weekly basis in order to observe certain performance indicators (Boston EMS [7]).

Boston was identified as one of the best concerning cardiac arrest survival rates in 2011. The RTQI team participated in this success by reviewing cardiac arrest cases that have occurred in Boston. For each case the team evaluates and enters case information, including pre-hospital electrocardiographic information, into an internal database. This database aids in in-depth

research for finding new treatment protocols and methods that can improve pre-hospital cardiac care (Boston EMS [7]).

Boston EMS was an early adopter of pre-hospital therapeutic hypothermia in 2008. This process involves cooling and maintaining the body at between 32-34^{o}C in the first 12-24 hours after cardiac arrest. The implementation of this process in pre-hospital care can help protect brain function, improve neurological outcomes and improve survival rates of cardiac arrest patients (Boston EMS [7]).

Boston EMS' "AED Alert" program is a system for tracking the location of publicly available Automatic External Defibrillators (AEDs). First implemented in 2009, the program involves the storage of publicly available AED locations in the Computer Aided Dispatch (CAD) system. This allows dispatch operators in the 911 call center to be alerted to the existence of an AED near a caller. These dispatch operators are then able to give the caller instructions on finding and using the AED. The availability of this information can mean the difference between life and death in cardiac arrest cases (Boston EMS [7]).

3.1.3 Fleet Services

Boston EMS' Fleet Services Division focuses primarily on ensuring vehicle and crew safety. All mechanics employed by Fleet Services are Automotive Service Excellence certified and have at least 10 years of prior repair experience. A large range of specialty vehicles is used by Boston EMS, including the new bariatric ambulance (Boston EMS [7]).

The bariatric ambulance is designed specifically to accommodate obese patients. Its 850 pound stretcher makes it easier to assist large patients and its 1,000 pound capacity hydraulic

lift aids paramedics with loading heavy patients into the ambulance. Both of these new features help to reduce the chance of injury for EMTs and Paramedics when coming to the aid of obese patients while providing the patients with improved comfort over standard ambulances (Boston EMS [7]).

The mainstay of Boston EMS' ambulance fleet is its state-of-the-art ambulance. This ambulance is tailored to the demands of the city of Boston. Outfitted with the most advanced pre-hospital care equipment available, it is staffed by two Paramedics. Routine preventative maintenance is performed on every Boston EMS ambulance and all have passed the annual State Office of OEMS inspection (Boston EMS [7]).

3.1.4 Training and Education

In order to work at Boston EMS, paramedics attend the Training Academy for a 6-month course. This course is taught by experienced training personnel and includes classroom work, field instruction, exercises and drills. Statistics from 2011 Annual Report show that 18 new paramedics graduated from the Training Academy (Boston EMS [7]).

Boston EMS also has a program specified for paramedics in the Northeastern University's College of Professional Studies. This program is taught by Northeastern instructors, and also Boston EMS staff educators. Students graduating from this program also get credit as undergraduate degree (Boston EMS [7]).

The third section of classes is a Basic EMT Course. This course offers classroom training, emergency room observation and an ambulance ride-along. It takes 150 hours and ends with an

examination. In 2011, there were 69 graduates that pursued the EMT-Basic certification. A comparison of training programs can be viewed in Table 5 (Boston EMS [7]).

Table 5: Comparison of Training Programs

Training Academy	Northeastern University's College of Professional Studies	Basic EMT Course
6 month course	4 month course	150 hour course
Taught by experienced training personnel	Taught by Northeastern instructors and Boston EMS staff	Taught by training personnel
Includes classroom work, field instruction, exercises and drills	Includes classroom work and field instruction	Includes classroom work, emergency room observation and ambulance ride-along
18 graduates in 2011	18 graduates in 2011	69 graduates in 2011

3.1.5 Emergency Preparedness

As mentioned before, Boston EMS is one of the best emergency systems in the world. It serves the Boston residents by protecting them from all kinds of disasters. Boston EMS offers specialized trainings through the DelValle Institute for Emergency Preparedness and the Boston Metropolitan Medical Response System (Boston EMS [7]).

The DelValle Institute of Emergency Preparedness was founded in 2003, in honor of Manual Del Valle who was a firefighter in the New York City Fire Department and was killed in a terrorist attack on September 11, 2001. DelValle is an institute for hazards training, Emergency Medical Services, public health and public safety personnel (Boston EMS [7]).

The goal of the institute is to decrease the public health and safety issues which occur with disasters. The institute reviews the abilities of emergency medical services and healthcare services. Additionally, DelValle also reviews how first responder and first receivers interact and

how their roles and responsibilities overlap. Finally, they review community emergency planning, especially for at risk communities. Along with Boston EMS and the Boston Public Health Commission (BPHC), the institute has a strong knowledge, experience and expertise background (Boston EMS [7]).

Statistics show that in 2011, 2,600 public health and public safety professionals graduated from DelValle. The institute has started seminars, launched a learning center, an e-course and online portal. Boston Metropolitan Medical Response System (MMRS) is another program associated with the emergency preparedness of the Boston EMS. Boston MMRS is a Federal Emergency Management Agency Grant Program. The goal is to ameliorate the health and medical preparedness. BMMR works to facilitate preparedness and a better planning in case of an emergency. This way, unpleasant consequences of a mass incident during the response period are reduced (Boston EMS [7]).

During 2011, MMRS maintained the first responder emergency pharmaceutical cache and also worked with community partners such as hospitals, health centers, private EMS services and long term care facilities. MMRS helped these health care providers by preparing the emergency plans for each, by identifying various solutions for addressing power problems and weather-related issues. Some other communities and workgroups MMRS worked with include: Patient Tracking, Medical Response to Radiant Events, the Go Team, UASI Medical Surge and the Boston Healthcare Preparedness Coalition (Boston EMS [7]).

3.1.6 Dispatch Operations

The Dispatch operations are in charge of deploying ambulances to the emergency scene. The emergency units are dispatched from the ambulance stations in which are strategically distributed throughout the city in purpose of getting best response time from the moment the patient dialed 911. Dispatch Operations have more responsibilities than just deploying ambulance to the emergency scene. Dispatch Operations is also in charge of prioritizing emergency calls and coordinating with other safety organizations such as the fire department and the police. They also work with the Metro-Boston Central Medical Emergency Direction (CMED). This is a special radio system which is used for the purpose of communicating patient needs from EMTs in the field and area hospitals throughout the Boston metro area. Figure 28 shows the response times for emergency calls over 2011 (Boston EMS [7]).

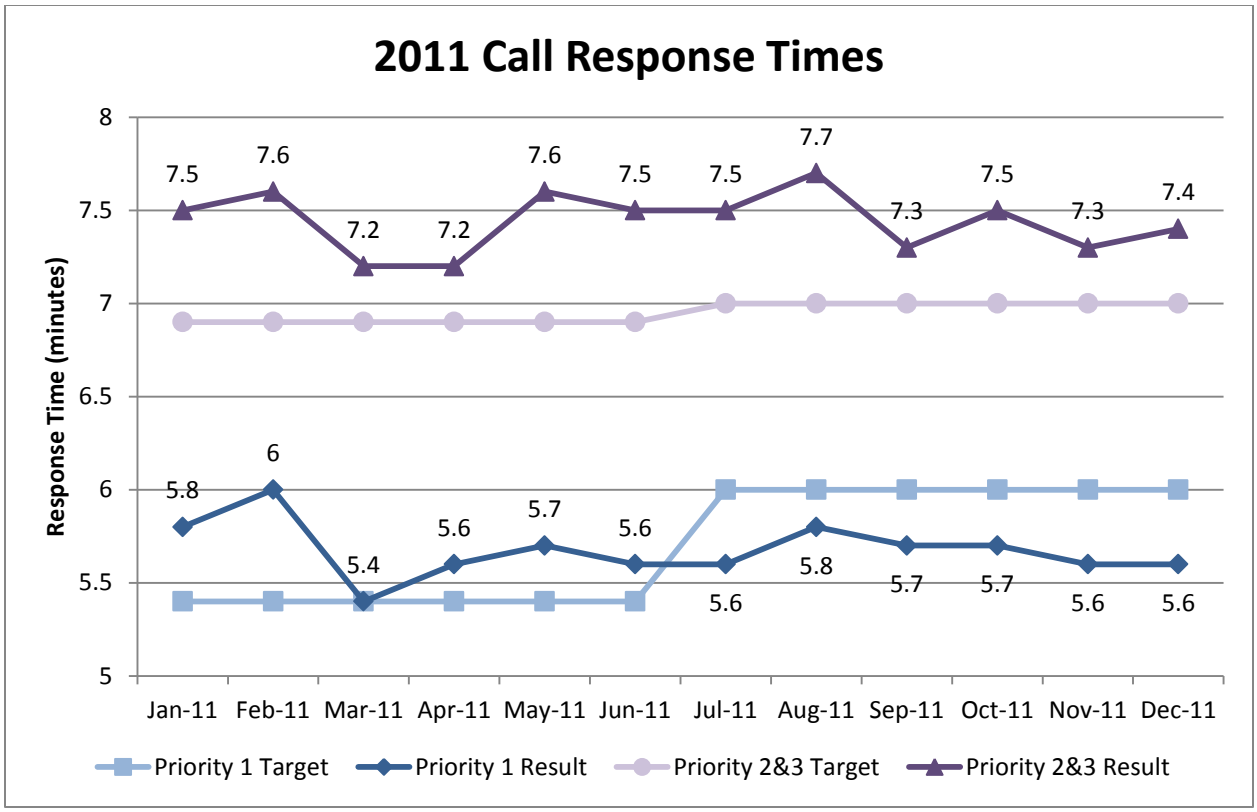

Figure 28: 2011 Call Response Times

To become a part of Boston's EMS dispatch operators, one would have to attend additional training in addition to that which was received in order to become an EMT. The supplemental training involves 19 weeks of specialization in emergency medical dispatch. This training is required because of the critical importance of retaining the stable and professional link between the public and the EMS crews in the field. Boston's 2011 Annual Report suggested that future improvements could include the implementation of a new policy which allows direct communication between Dispatch Operations and Logan Airport and Mass Highway Operations' dispatch centers. The radio network has also been expanded to allow Boston EMS to operate more effectively along with other ambulance services in Boston. With many more innovations, Dispatch Operations, which can be seen in part in Figure 29, plays a major role in the success of Boston EMS (Boston EMS [7]).

Figure 29: The entrance to Boston EMS' Dispatch Operations

3.1.7 Special Operations

The Special Operations is a division in the medical field where they plan ahead for quick emergency responds in special events, and unplanned disasters. This division oversees the bicycle defibrillation unit, the tactical response unit, the harbor patrol unit, the rapid deployment team and HAZMAT response efforts. The Special Operations division is required to be fully prepared for special events in Boston, such as the Boston Marathon, 4th of July celebrations and other festivals and parades. These events contain enormous amount of people which means that emergency services need to be ready to handle abnormally large loads during these times (Boston EMS [7]).

Special Operations also goes through exercises to maintain the ability of successfully responding and managing several emergency events simultaneously happening in Boston's region. According to Boston's 2011 Annual report, the Special Operations division also insures EMS and police personnel are prepared to work effectively together. This division worked with the Boston Police Academy to design an active shooter program for training EMS personnel and police officers and ensure that they work together effectively, should such a scenario occur. This training focused on situational awareness, providing medical care while maintaining police protection and rescue tactics (Boston EMS [7]).

3.2 New York Fire Department

Due to its large population, New York City requires a powerful, quick, well-equipped and effective Emergency Medical Service System. According to the Fire Commissioner, Nicholas Scoppetta, The Fire Department New York (FDNY) was faced with many challenges when he came to office. The Commissioner discussed these after the September 11, 2001 terrorist attack, stating "Our greatest tasks were rebuilding the ranks and maintaining our excellent record of service." FDNY also works to improve and enhance its safety technology to better serve the 8.4 million residents and the 47 million annual visitors to New York City (FDNY [18]).

FDNY EMS is the largest municipal EMS in the United Stated, according to Fire Department City of New York Annual Report 2008-2009. The EMS is largely staffed with 3071 officers, Paramedics and EMTs. They are assigned over five divisions, and 30 EMS stations citywide. FDNY EMS has enormously improved over the years, specifically after 9/11. Since September 11th, the FDNY EMS has added special unites for dealing with hazardous materials, weapons of mass destruction and rescue from collapsed buildings. The chart below displays the budget funding since 2005-2008 with a positive increase slope as an indication of FDNY improvements (FDNY [18]). The Adopted Expense Budget Funding can be seen in Figure 30. This figure shows an increasing budget over 4 years.

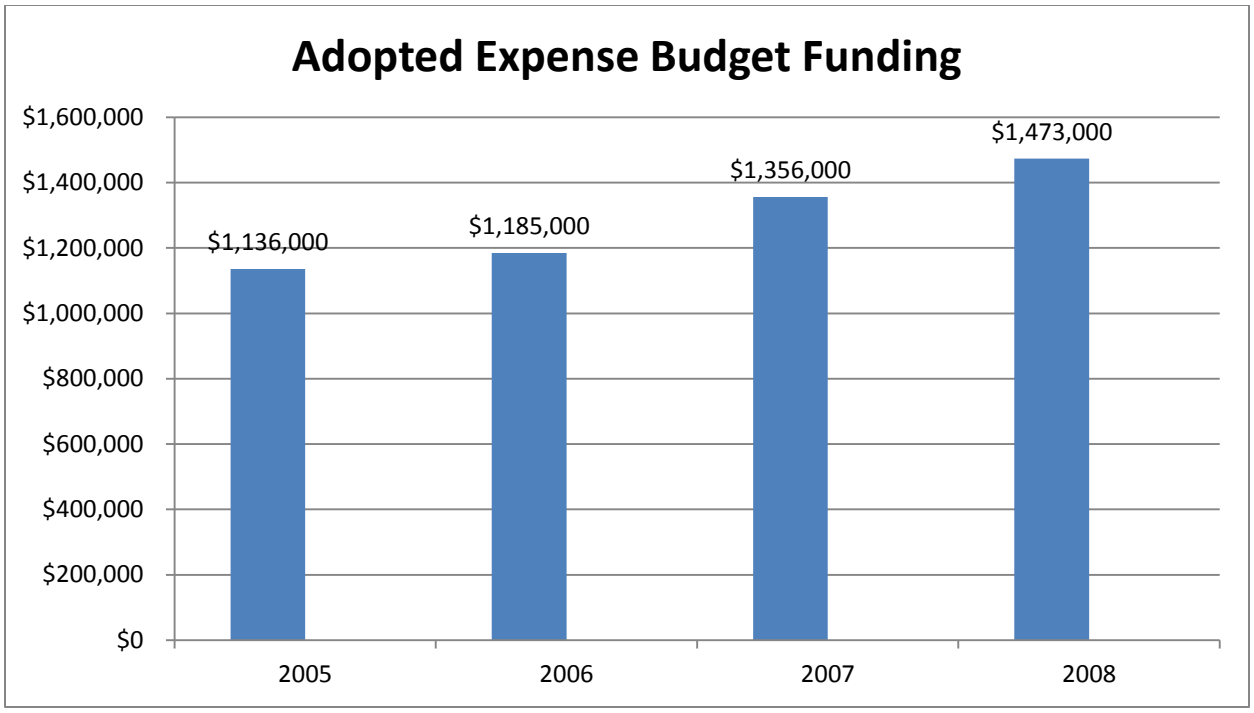

Figure 30: Adopted Expense Budget Funding (2005-2008)

The FDNY EMS implemented improvements in pre-hospital care such as triage and transport of critically ill patients citywide (FDNY [18]). Additional to these improvements, EMS is adding crews with the knowledge of different languages to help communicate with the non-English speaking patients. These languages include English, Spanish, Korean, Chinese, Urdu, Arabic, Russian, Yiddish, Italian, and French Patois/Creole (FDNY [18]).

3.2.1 New York City Fire Department Sustainability Initiatives

PLANYC 2030 is a 30-year set of sustainability plans introduced by Mayor Bloomberg in 2007. One aspect of this effort is to introduce green technology to the FDNY's EMS stations, ambulances, and support vehicles. This technology will be integrated over time through the cooperation of the Building and Facilities Maintenance, Fleet and Technical Services, and Technology Development and Systems divisions of the FDNY (FDNY [18]).

In order to reduce the need for heating and air-conditioning, green roofs are being integrated into new buildings such as EMS Station 3 in the Bronx. Another feature being introduced at some EMS stations is the use of solar-powered heating systems. New FDNY vehicle purchases now consist of more fuel efficient hybrid vehicles and vehicles that convert nitrous oxide emissions into ammonia. In order to reduce electricity usage, lighting systems in the Queens Fleet Services Shops will be upgraded (FDNY [18]).

3.2.2 Training

New curriculums were developed for each rank, from the probational EMT to Deputy Chief. One of these curriculums is management skills and training in fire and building codes for lieutenants and captains. Another consists of rules and regulations for battalion and deputy chiefs. The Building Inspection and Safety Program (BISP) went into service in July 2008. Due to BISP, more than 700 Company and Chief Officers have received this training (FDNY [18]).

The Bureau of Training initiated a series of drills at the Fire Academy around June 2008. The purpose of this training was to train units for response to a terrorist attack involving a bus bombing. It also included that practice of proper use of radiation-detection meters and Personal Protective Equipment (PPE) and to identify potential secondary devices such as wires, batteries and timers. The EMS units joined the Fire Officers and Firefighters in these drills in March 2009. The EMS units had the opportunity to train in response to detonation of Improvised Explosive Devices (IEDs) on a city bus with several victims. EMS worked and learned how to prioritize patient treatment and transport. The EMS division has also focused on improving cardiac patients' survival. Automatic CPR devices provide feedback on the patient's

condition in response to the EMS and Fire CFR-D members who administrates CPR to patients (FDNY [18]).

The Incident Management Team (IMT) is a FDNY training program which has trained more than 140 members. FDNY's IMT has been deployed for wildfires during the wildfire season. This experience gave FDNY members the opportunity to refine their skills as they relate to logistics, planning, finance, public information and communicating with outside agencies (FDNY [18]).

A special program was created in order to improve the survival of victims of carbon monoxide poisoning and cyanide toxicity caused by smoke inhalation. This program increased the use of the Masimo Rad-57 Pulse Carbon Monoxide Oximeter. This improves the ability of EMS crews to determine the toxicity levels of carbon monoxide in a patient's blood. It also evaluated how useful carboxyhemoglobin measurements were at the scene. Finally, it expanded a pilot program for increasing fire department and EMS interoperability when responding to two-alarm and greater fires, HAZMAT situations, and mass casualty incidents (FDNY [18]).

3.2.3 Major Incident Responses

FDNY's responsibilities consist not only of firefighting but also multiple-alarm or major emergency response events. FDNY works also as Special Operations Command and EMS. FDNY can achieve this broadness because of the interaction and cooperation of its multiple units and coordination without outside agencies. This section provides some examples of emergency cases in years 2007, 2008 and 2009 (FDNY [18]).

On July 18th, 2007, there was a steam explosion at 370 Lexington Avenue/41st Street. This resulted in a 150-foot geyser, consisting of hot mud, rocks, and steam, in the middle of the street. Search and rescue, EMS, structural evacuation, and hazmat life safety operations and mass decontamination were employed to handle the incident (FDNY [18]).

The explosion also trapped a bus and its occupants. Firefighters braved steaming water to carry the occupants to safety. Approximately 200 people were assisted over the course of the event. As a result of a heart attack, one woman died at the scene (FDNY [18]).

Two crane collapses occurred in New York City in 2008. The first occurred at 305 East 50th Street/2nd Avenue on March 15th 2008. A 200-foot, 250-ton tower crane broke away from a building which was under construction, causing a total pancake collapse of a brownstone building at 311 East 30th Street. Firefighters had to brave gas and water leaks to remove victims and debris and perform a void search. This was the first time a Rescue Medic worked with a Rescue Company and provided crush syndrome medicine (FDNY [18]).

The second, smaller, incident took place on May 30th, 2008 at 354 East 91st Street/First Avenue. A Planning Vehicle and Incident Action Plan were used in this incident, as well as maps from Geographic Information Systems, which provided layouts of surrounding buildings. These two incidents have prompted the FDNY to take a look at new technologies for providing real time accurate information to Incident Commanders. These incidents ensured that the department needed to change its course of action in case of crane collapses in the city (FDNY [18]).

On January 15th, 2009, US Airways Flight 1549 suffered a bird strike shortly after taking off from LaGuardia Airport, followed by a loss of thrust in both engines. All 155 passengers and crewmembers survived the successful emergency landing on the Hudson River. Within half an hour, they were all safely evacuated from the floating aircraft. There were no major injuries; some suffered from minor cuts and bruises. Ferries transported the passengers and crew to land. The airliner, which had lost an engine on landing, had its remaining fuel offloaded to prevent further environmental contamination from leaks. Finally, the aircraft was towed away. This was a successful rescue incident (FDNY [18]).

3.2.4 Improvements

In beginning of 2009 modifications came to the system such as, FDNY ambulances are performing transportation of cardiac patients directly to hospitals that use more advanced cooling therapy. According to FDNY 2008-2009 annual report, the chance of brain damage can be reduced and the chance of survival can be increased if chilled saline fluids are administered intravenously after a heart attack. Few months later another modification came through, doses of Epinephrine are now allowed on all types of ambulances compared to only ALS ambulances (FDNY [18]).

A breakthrough which also occurred in 2009 is the smoke inhalation project. The project focuses on training EMS personnel to rapidly identify patients with cyanide poisoning, and equipping them with lifesaving medications. FDNY EMS also partnered with several hospitals throughout the city in order to identify places which can treat patients, using hyperbaric medical therapy, for smoke inhalation, cyanide poisoning, decompression sickness and carbon monoxide poisoning (FDNY [18]).

In addition to these improvements, SmartCPR and STEMI programs have been initiated to improve survival of hospital cardiac arrest and heart attack victims. The improvements in response time over the years can be seen as well. There is about 7.59% decrease of response time in 5 years for Medical Emergencies (Fire Units Only), and also an obvious decrease in Seg 1-3 Life Threatening (for both EMS Units and Fire Units) as well. This is shown in Figure 31 below (FDNY [18]).

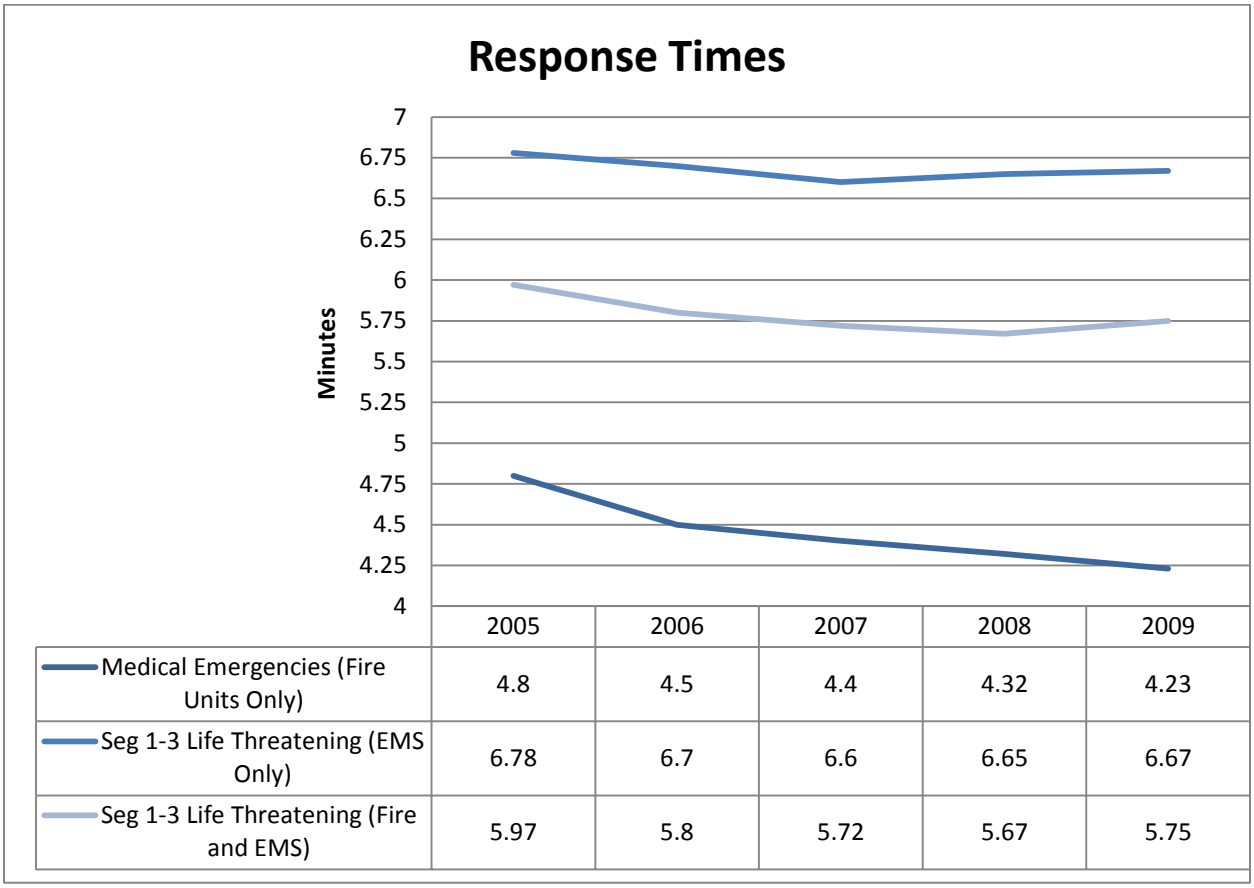

Figure 31: Response Times (2005-2009)

3.3 Seattle EMS

King County, Washington, depicted in Figure 32, contains Seattle, a well-known city across United States. Its EMS provides high quality pre-hospital care to over 1.9 million people in over 2,134 square miles (King County EMS [29]).

Figure 32: A Map of King County, WA

According to an annual report, in 2011 EMS provided assistance to over 164,000 calls for medical emergencies in less than 5 minutes on average. This includes responses 1,047 cardiac arrests and over 34,000 trauma calls (King County EMS [29]).

3.3.1 System Overview

When a person calls 911 for a medical emergency, the Medic One/EMS system will be used. The system is managed by the King County EMS division which relies on partnerships with fire departments, paramedic agencies, EMS dispatch centers, and hospitals (King County EMS [29]).

3.3.2 EMS Division Programs Overview

In King County, EMS is served by the most appropriate care provider. There are five tiers in the Medic One/EMS system, which are shown in Figure 33 (King County EMS [29]).

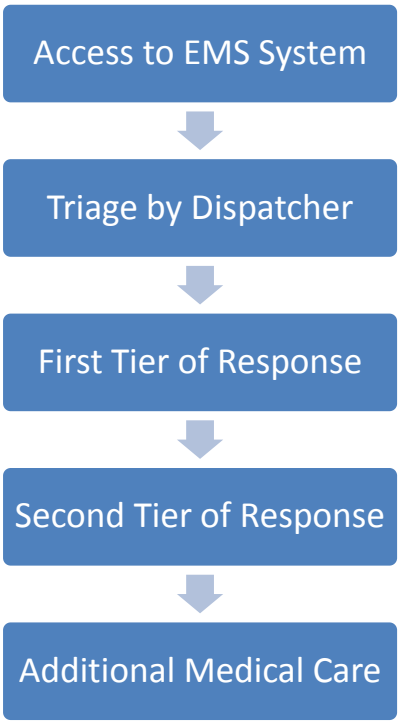

Figure 33: The Five Major Tiers in the Medic One/EMS System

- Universal Access: Either a patient or a bystander contacts Medic One/EMS system through calling 911 (King County EMS [29]).
- Dispatcher Triage: The Dispatcher is the one to determine the appropriate level of care needed. Depending on the situation, dispatchers will either send Basic Life Support Services or Advanced Life Support Services. Dispatchers are trained to then assist pre-arrival instruction for most medical emergencies and also if necessary guide the caller through life-saving steps. This includes Cardiopulmonary Resuscitation (CPR) and Automated External Defibrillator (AED) instructions, until the Medic One/EMS provider arrives (King County EMS [29]).
- Basic Life Support Services: BLS personnel are the first responders to an incident, averaging less than five minutes arriving to the scene. They are staffed by firefighters

trained as EMTs. They provide immediate basic life support medical care which includes advanced first aid and CPR/AED to stabilize the patient (King County EMS [29]).

- Advanced Life Support Services: ALS personnel are Paramedics that provide emergency medical care, including life threatening cases. Roughly 30% of calls are responded to by paramedics trained in ALS. ALS is provided by six paramedic provider agencies in King County, Bellevue Fire Department, Redmond Fire Department, Seattle Fire Department, Shoreline Fire Department, King County Medic One, and Vashon Island Fire & Rescue (King County EMS [29]).
- Transport to Hospitals: After the patient is stabilized it is then decided where to transfer him/her; this includes either a hospital or a clinic for further medical attention is needed (King County EMS [29]).

3.3.2.1 Training

The training for EMTs contains more than 140 hours of basic training and hospital experience with additional training in cardiac defibrillation (electrical shocks) given to restore a heart rhythm. The EMTs are certified by the state of Washington after they are done with the training, however to maintain their certification they need to complete ongoing education (King County EMS [29]).

The training for Paramedics consists of over 2,500 hours in the University of Washington/Harborview Medical Center Paramedic Training Program. ALS Paramedics, just like BLS personnel, are required to complete continuing medical education in order to maintain

their certification. Throughout ALS Paramedics' education, they can provide airway control, heart pacing, dispensing of medicine, and other lifesaving procedures (King County EMS [29]).

3.3.2.2 EMS Divisions

The EMS Division manages the core Regional Services that support key elements of the system such as Uniform training for EMTs and Dispatchers, Financial/administrative management, injury prevention programs, Regional medical control and quality improvement, Regional data collection and analysis, and Regional Planning for the EMS system. The EMS Division also manages innovative projects and operations called Strategic Initiatives. According to the King County EMS 2012 annual report, these initiatives were created with the goal of improving the quality of service, growth and expenditures within the King County EMS system (King County EMS [29]).

3.3.3 Medical Quality Improvement

The Medical Quality Improvement performed various evaluations of the EMS system in order to improve the quality of EMS patient care in King County. These evaluations resulted in better care and health of the King County residents. Improvements include:

- Cardiac Arrest Quality Assurance – In order to deliver quality care to each patient who suffers a cardiac arrest, dispatch, BLS, ALS, defibrillator and hospital records are reviewed for each case (King County EMS [29]).
- Dispatcher Assisted Resuscitation Trial – this study analyzed the cardiac arrest outcomes when dispatch was provided with assisted CPR (King County EMS [29]).

- Comprehensive Heart Attack Surveillance and Evaluation- a goal was set by the American Heart Association: 90 minutes “from the time of first medical contact until surgical opening of the arteries in patients with a STEMI” (King County EMS [29]).
- Airway Quality Assurance Report/ Safety of Central Venous Lines
- Supporting Public Health with Emergency Responders- explored if counseling by EMTs to elderly residents could be easily done (King County EMS [29]).
- Resuscitation Academy- Shared local strategies for success and also gave other communities the opportunity to better their cardiac arrest care.
- EMT Advisory Council- It was created in 2009 for the purpose of strengthening the connections between EMS Division and EMS personnel. This program, “engages field providers in shaping policies, programs, research designs, and day-to-day service interactions” (King County EMS [29]).
- Limited English Proficiency (LEP) Callers Study- This study was completed in 2010 to calculate LEP and also, “the provision of bystander CPR to victims of cardiac arrest” (King County EMS [29]).
- Socioeconomic Status Study- This study was completed in 2010, in the purpose of comparing the relationship between traditional socioeconomic status characteristics and survival from cardiac arrest (King County EMS [29]).
- Long Term Outcome of Pediatric Cardiac Arrest- It’s a study aimed to help understand the long term implications for children who survive to hospital discharge. This is done in hope of helping guide care, “and expectation for clinicians and families whose child suffers a cardiac arrest” (King County EMS [29]).

- Cardiac Arrest in Exercise Facilities- This study examines cardiac arrest at exercise facilities, in hopes of being used to assist planning efforts for medical emergencies at the facilities (King County EMS [29]).
- Antiarrhythmic Used in Cardiac Arrest- This looks closely at outcomes of non-shockable cardiac arrest patients. It also looks at, the administration of cardiac arrest medications during on-going uninterrupted CPR after defibrillation shock (King County EMS [29]).
- Police Defibrillation- This plan equips police with automatic external defibrillators (AEDs) in order to improve survival since police usually arrive sooner to the patient than traditional EMS (King County EMS [29]).
- EMS Quality Improvement Audits- According to the annual report, "in 2011, the Medical Quality Improvement (QI) section conducted focused QI audits to assess BLS and ALS responses to various critical conditions. These reviews are distributed to local fire chiefs and training officers to provide feedback on patient care and guide the development of effective training" (King County EMS [29]).
- Stroke Surveillance- "An emphasis has been placed on the use of fast (fast- is based on the Cincinnati Pre-hospital Stroke Scale (CPSS) and focuses on three symptoms: facial droop (F), arm drift (A), and speech problems (S), with 'T' for 'time' to emphasize the importance of recognition and early treatment following symptom onset) screening tool to identify stroke patients, reducing on-scene time, transporting patients to qualified stroke hospitals, and notifying hospitals of the arrival of possible stroke patients" (King County EMS [29]).

3.3.4 EMS Awards

Seattle EMS rewards its dedicated personnel each year by giving “Critical Emergency Medical Services Incident Award”. These awards are given as result of the outstanding and critical working, sustained also exemplary performance of medical call receivers and dispatchers who work as partners with the Seattle EMS (King County EMS [29]).

In 2012, a dispatcher identified the cardiac arrest of a patient and instructed the Dispatcher-Assisted CPR instructions promptly so that the patient survived. Also an incident happened where the dispatcher helped critical prolapsed cord childbirth through the phone. These people qualified to receive the “Critical Emergency Medical Services Incident Award” (King County EMS [29]).

3.3.5 Communities of Care

Seattle EMS works with regional ALS providers, fire departments and the Washington State Department of Social and Health Services – Residential Care Office. These institutions aid the EMS Division by educating the administration and staff of facilities that use EMS services. The training consists of medical and non-medical classes. The tiered response system, private ambulance services and expectations by calling 911 are provided over the training program (King County EMS [29]).

In 2011, approximately 180 personnel of 30 different facilities took the Communities of Care training. A study was performed to evaluate the efficiency of this training. The results indicate that after training, there is a 59.5% decrease in calls to 911 and a reduction to lift-assist calls from 30 to 0 (King County EMS [29]).

Evaluation from participants and administrators were 100% favorable. This program plays an important role for Seattle EMS. It is a provision of preventive care to high-risk personnel. One can see the importance of dispatching where the dispatcher should be able to understand and coordinate the triage requested, provide pre-arrival instructions and also determine if a call is emerge or not. Some non-emergent call examples could be lift-assists, delay of private ambulance and confusion about patient care responsibilities. Post-training examples showed that these types of non-emergent calls were replied by the instructions of dispatcher. This way, paramedics in ambulances focused better on real emergency situations. Future plans for the Seattle EMS is to offer training and intervention to other states. It is demonstrated that this system improves performance and strength of the EMS (King County EMS [29]).

3.3.6 Injury Prevention

Seattle EMS voted for an extra prevention against injuries, which is the leading cause of death for the young population. In order for a better understanding of the importance of injury prevention, “Child Passenger Safety Program” and “Distracted Driving Project” were conducted in year 2012 (King County EMS [29]).

3.3.7 EMS Child Passenger Safety Program

It had been demonstrated that child transportation in car seats that are large for them increase the risk of serious and fatal injuries by more than 50%. The Child Passenger Safety Program trains car seat technicians. Technicians assist to pregnant mothers and install free car seats to low-income families (King County EMS [29]).

3.3.8 Distracted Driving Project

In 2009, it was reported that 5,400 people died and 448,000 injured in car crashes because of a distracted driver. It was also noted that among these numbers nearly 1000 deaths and 24,000 injuries occurred when driver was using cell phone (National Highway Traffic Safety Administration [44]). This is a good demonstration that shows the main cause of distraction including cell phone use.

EMS trainers went to public and private high schools and gave speeches on the dangers of texting and driving. Students were provided with evidence of how dangerous use of cell phone can be while driving (King County EMS [29]).

3.3.9 EMS Administration

The Seattle EMS Administration System provides financial and administrative leadership while supporting all customer needs. It also manages the financial business with the EMS Strategic Plan and participates in countrywide business improvement processes. It defines the stakeholders and collaborates accordingly (King County EMS [29]).

3.3.10 King County Medic One Program

King County Medic One or KCM1 is a regional EMS provider. KCM1 serves 690,000 people in an area of approximately 450 square miles in the south of King County. KCM1 provides Basic Life Support, Advanced Life Support and hospital-based care. In year 2011, it has been recorded by King County's 2012 EMS report that KCM1 responded to 13,054 calls including pediatric patients, mass casualty motor vehicle crashes and cardiac emergencies (King County EMS [29]).

Number of paramedics working in the KCM1 is 70. These personnel work together with the fire department, 24 hours a day and every day of the year. This result in a high-quality and cost-effective emergency medical care service where no elimination to separate facilities is needed (King County EMS [29]).

The “medical model” of KCM1 is very important for the program. According to the model, it is required to have best-trained, most-experienced paramedics who are critical and also integral. This way KCM1 achieves the highest benchmarks of EMS (King County EMS [29]).

3.3.10.1 King County Medic One Medical Direction

The Medical Program Director is Dr. Tom Rea assisted by four Associate Medical Directors. Direction division is responsible of quality review, guidance for procedures, equipment and training needs. Proactive paramedic implementation and involvement is emphasized (King County EMS [29]).

3.3.10.2 Training

There are four levels of training in KCM1: Initial training, continuing education, care under fire and testing new MCI protocols. Initial training is a 10-month program. It is defined to be as the most comprehensive and intensive program in the nation. Classes are provided in the University of Washington, Harborview Medical Center. Training consists mostly of classroom experience, field care and clinical education (King County EMS [29]).

Continuing education covers a broad range of topics and formats. It is a 50-hour course and includes seminars, showing of critical paramedic skills, important clinical scenarios and also quarterly meeting with KCM1 Medical Directors (King County EMS [29]).

Care Under Fire is a training program for police officers and SWAT team members. Course trains personnel with self-protection skills and what-to-do in a scene before EMS personnel arrives. It has been recorded in the 2012 Annual Report that currently 480 officers have been trained and some others will continue their training over the next months (King County EMS [29]).

KMC1 has tested and also practiced the new Mass Casualty Incident (MCI) during a nine-day drill at the Kent Showare Center in the year 2012. More than 480 EMTs and paramedics were trained by testing of the new MCI protocols in this process. The following table defines and compares the four different education systems in KCM1 (King County EMS [29]). Figure 34 defines and compares the four different education systems in KCM1.

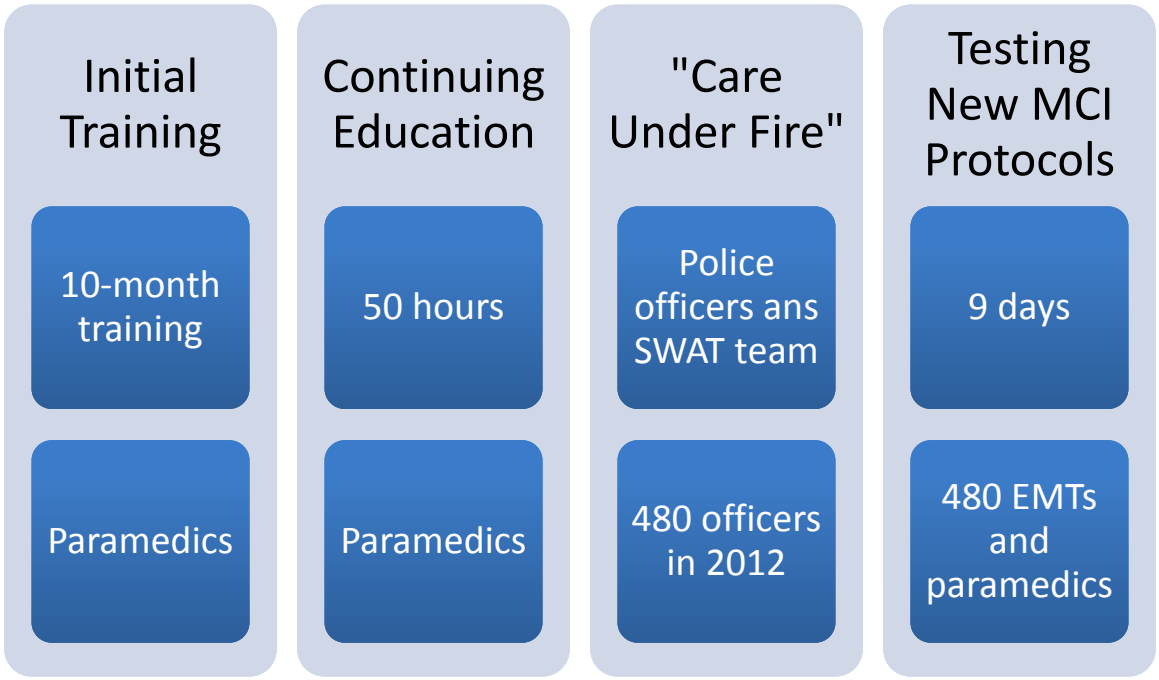

Figure 34: Different levels of training in KCM1

3.3.10.3 Operations, Preparedness and Safety

KCM1 uses the Physio Control Lifepak 15 which is a new standard monitor in emergency Advanced Life Support care. It is a monitor that has WiFi capabilities, allows rapid information flow and gives feedback from the Medical Director to medics. Time has shown that the use of Physio Control Lifepak 15 has ameliorated emergency preparedness and safety in a very positive way (King County EMS [29]).

3.3.10.4 Effectiveness

KCM1 is reported to be one of the most effective programs in the EMS field. Furthermore, for better results future plans include using new "Terra Star" trucks as emergency response vehicles. These trucks are designed to carry a newly designed patient care compartment, provide a better comfort, safety and efficiency (King County EMS [29]).

3.3.10.5 Administration

KCM1 consists of 70 employees in 10 medic unit locations. Administration is responsible of supporting all operations, 24/7, manage and record finances and vendors, procure supplies. KCM1 also works on Regional Medical Supplies and Equipment to purchase medications and contracts (King County EMS [29]).

3.3.11 EMS Funding and 2012 Financial Plan

Budgets play a large role in the funding of any organization. All organizations have a set amount of funding which must be distributed among their divisions in a way that best benefits the organizations' ability to function. King County Emergency Medical Services also has to

balance a budget in a manner that can best support the development and functionality of its EMS services.

3.3.11.1 Expenditures

EMS revenues support four major activities related direct service delivery or support programs to the following:

- Advanced Life Support Services – Receives of 60% of EMS funds.
- Basic Life Support Services – Receives an estimated 26% of EMS funds.
- Regional Support Programs – Approximately 10% of funds spent in 2011.
- Strategic Initiatives – Funded with lifetime budgets and these budgeted amount by year is adjusted to reflect changing cash flows based on project needs

Figure 35 is a chart which represents the 2011 expenditures for each of the support programs described above. As shown below, about two thirds of the money is consumed by Advanced Life Support Services. Roughly one-quarter of the money goes into Basic Life Support services. The remainder of the money goes into Regional Support Programs, Strategic Initiatives and the Auditor's Office (King County EMS [29]).

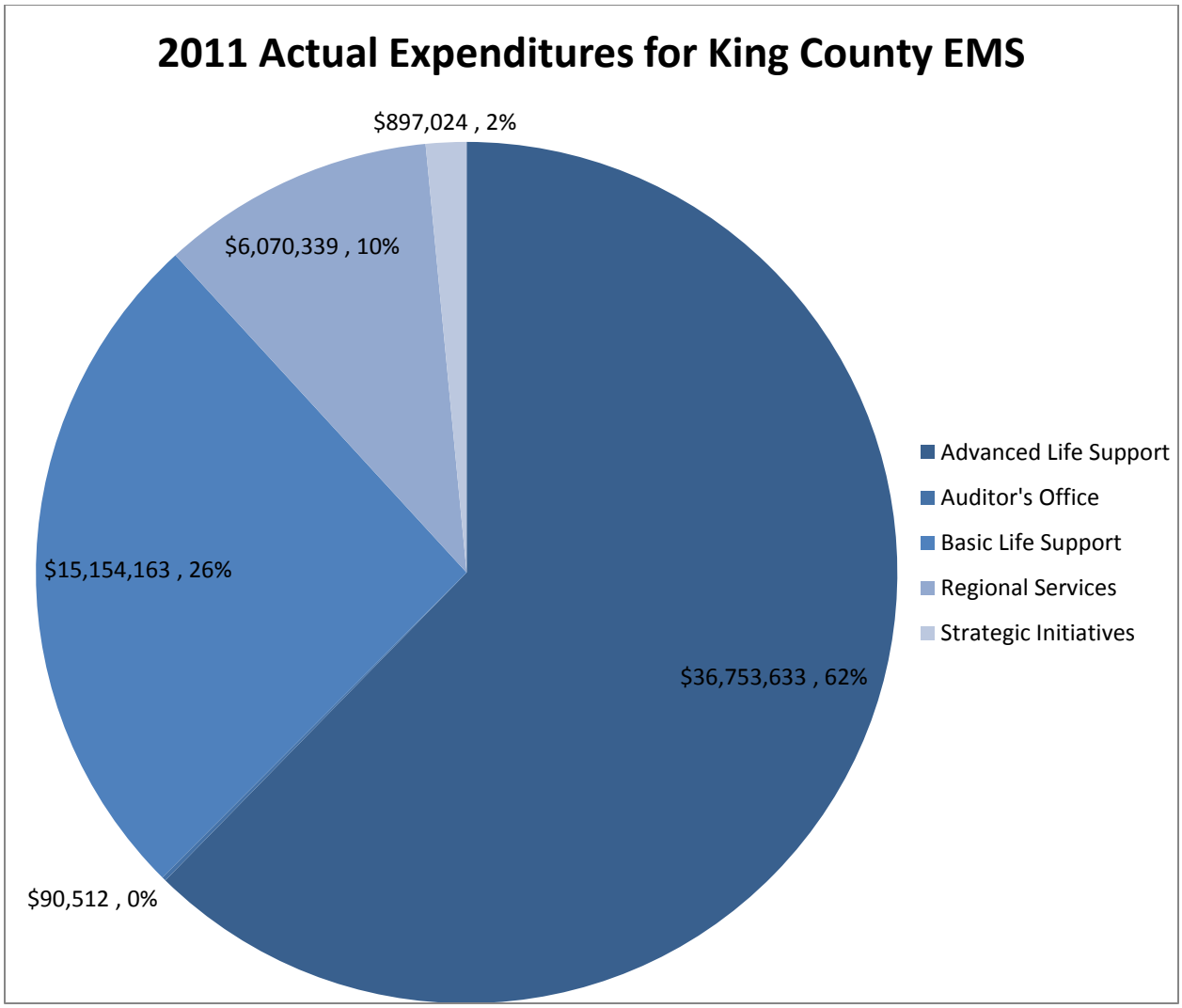

Figure 35: 2011 Actual Expenditures for King County EMS

In Figure 36, one can see the budget for the year 2012 divided into the same programs as the chart above. As shown in the graph, more than half of the budget falls into the Advanced Life Support program. However, about one-quarter of the budget goes into the Basic Life Support program. The remainder, which is about less than one-quarter of the budget, is divided between the Regional Services and Strategic Services, since the Auditor's Office obtains 0% of the budget (King County EMS [29]).

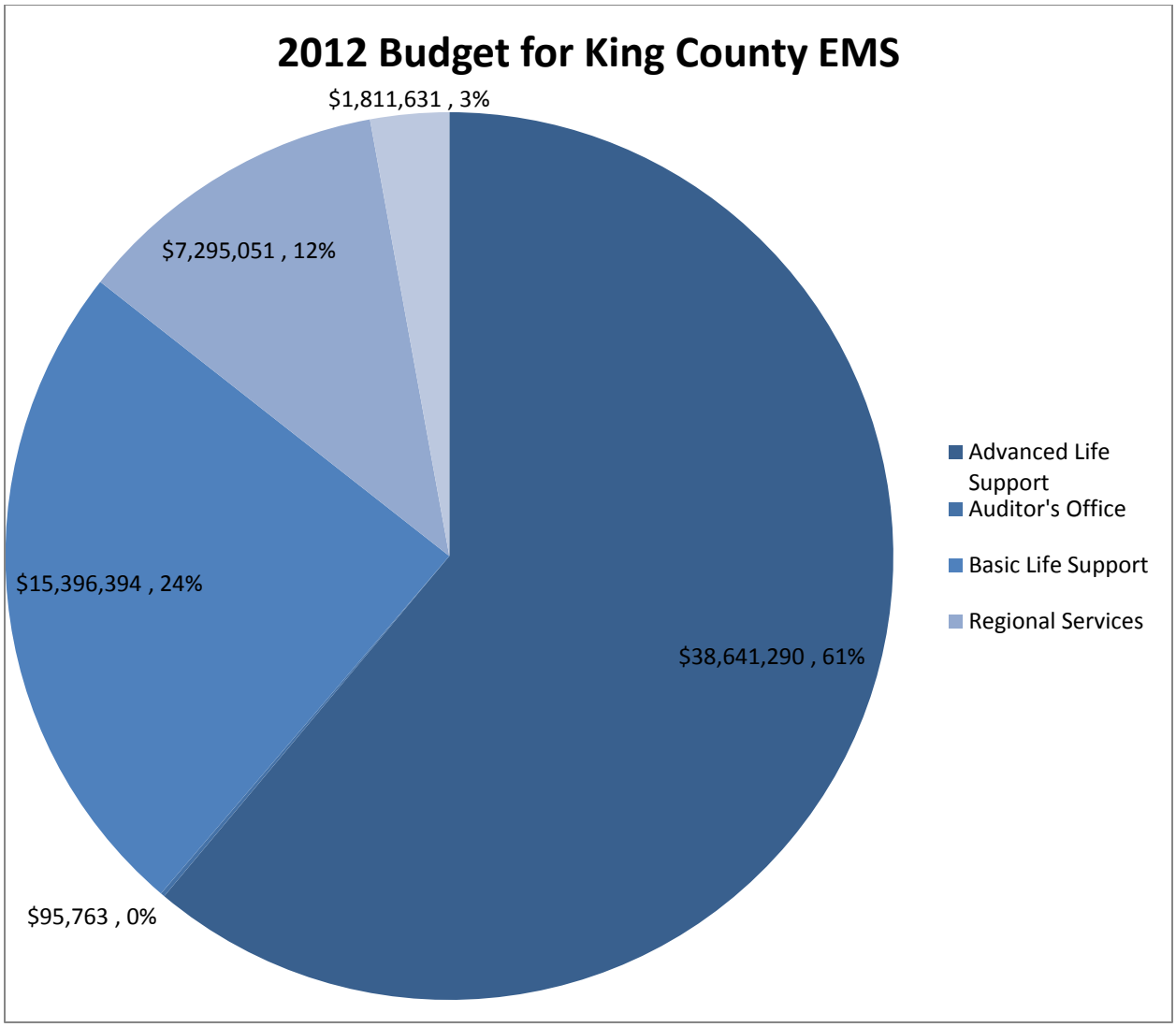

Figure 36: 2012 Budget for King County EMS

The Regional Support Services and the Actual Expenditure in 2011, which can be viewed in Figure 37, shows how the 2011 expenditure money is divided between the programs that the EMS supports. As shown in the graph, highest expenditure is for the Management and Finance program, followed by Indirect and Overhead spending. This is followed by the Community Program and Education as well as Strategic Planning and Data Management Program. The Medical Control and Emergency Management Program and the Training and Continuing

Education Program follow in terms of expenditure. The least money is obtained by the Infrastructure Program (King County EMS [29]).

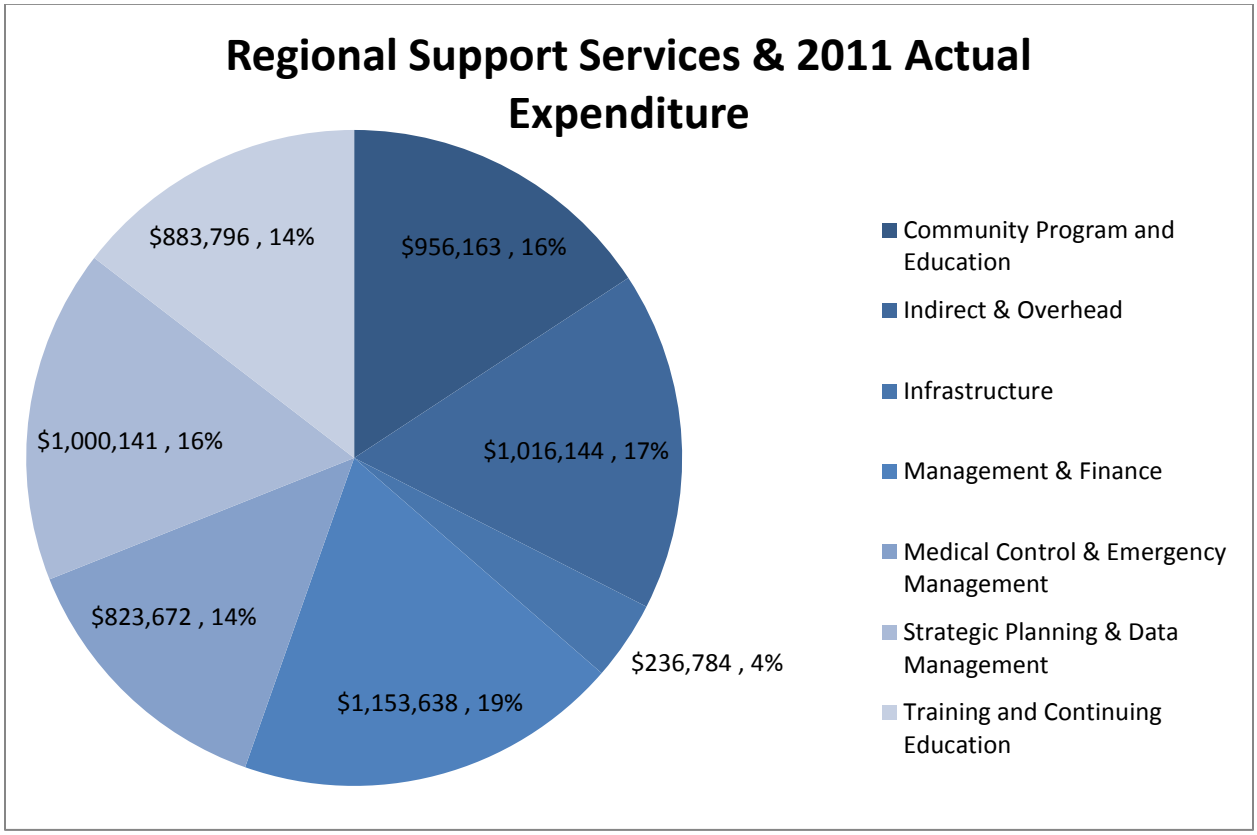

Figure 37: Regional Support Services & 2011 Actual Expenditure for King County

3.3.11.2 EMS Grants, Donation, and Entrepreneurial Projects related to Public Health

The EMS Division has been very successful in writing and competing for research grants. The EMS Division works through the EMS Grants Group and the Center for Evaluation of EMS located in the Public and Health Fund. In the year of 2011, the EMS Division was awarded a 5-year $1.3 million grant from the Medtronic Foundation. This grant had the purpose to help the Heart Rescue Flagship Program improve effects from sudden cardiac arrest throughout Washington States. The focus of the program was mainly on community, pre-hospital, and

hospital response levels of care. In addition, in the year of 2009 the EMS was also successful in obtaining a $2.6 million dollars grant awarded. The Fund Agency that had the honor to award this grant to the EMS was the Life Sciences Discovery Fund Agency. The grant program was for four years long with the purpose of supporting the Program to Integrate Technology and Cardiac Arrest Resuscitation. This is a series of projects intended to develop and advance new technologies to better improve the care and treatment of out-of-hospital cardiac arrest (King County EMS [29]).

The EMS Grant Group aims to find research grants that would not obligate the EMS program to fund further services. Also, the results of the various researches have been incorporated into the existing EMS services impacting most of the standards and protocols (King County EMS [29]).

CHAPTER 4. CONCLUSION: A COMPARISON OF EMS MODELS IN SELECTED COUNTRIES

4. Introduction

Throughout this IQP, the EMS systems of selected countries and cities have been studied. This project looked at how their EMS systems functioned, how they were funded, what types of training they had and so on. In this concluding chapter, a comparison of the major categories related to these EMS models in the selected countries using several tables and graphs is presented.

4.1 Hospital Bed Density and Physician Density

Hospital bed density is a statistic which is measured by the number of hospital beds per 1,000 people. It can be used as an indicator as to the availability of resources for treating a population. This, however, is not an indicator of healthcare quality or sophistication. In this aspect, the top country (of the selected countries) was Germany, followed by Lithuania and the People's Republic of China. The Sultanate of Oman came in at the bottom in this statistic, along with the United States and Portugal.

Physician density is measured by the number of physicians per 1,000 people. It may help determine healthcare quality by showing how many patients an individual doctor might be responsible for, overall. This statistic does not factor in the overall health of the population, or the geographical distribution of doctors, which are limiting factors for its usefulness in this area. Of the selected countries studied, Greece was the top country, followed by Portugal and then Lithuania. South Africa was at the bottom in terms of physician density, followed by Hong Kong and the People's Republic of China. Both hospital bed density and physician density can be seen in Figure 38 (World Bank [56]).

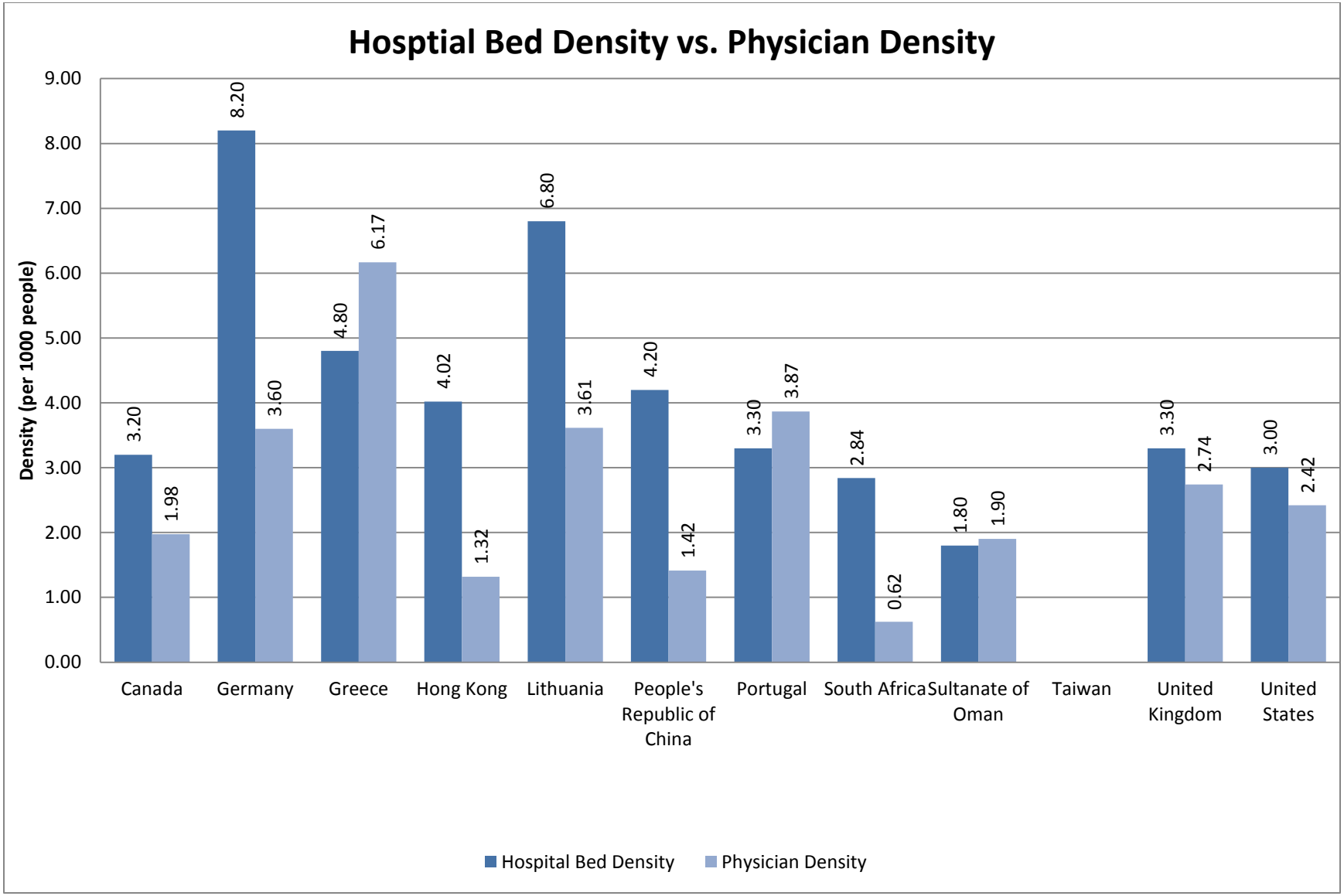

Figure 38: Hospital Bed Density vs. Physician Density

4.2 Total Healthcare Spending in G7 Countries

The bar chart shown in Figure 39 illustrates the contributions from public spending and private spending towards total healthcare spending in the G7 countries. This data determines how much of a role public versus private spending has these countries healthcare.

The United States has the highest total healthcare spending between the other six countries. It also has the highest private spending. United Kingdom, on the other hand, has the lowest total healthcare spending, including the lowest private spending. Germany has the highest public spending while Italy has the lowest. While it might look like these countries have comparable levels of public healthcare spending, it is important to note that the quantity of people living in these countries differs significantly.

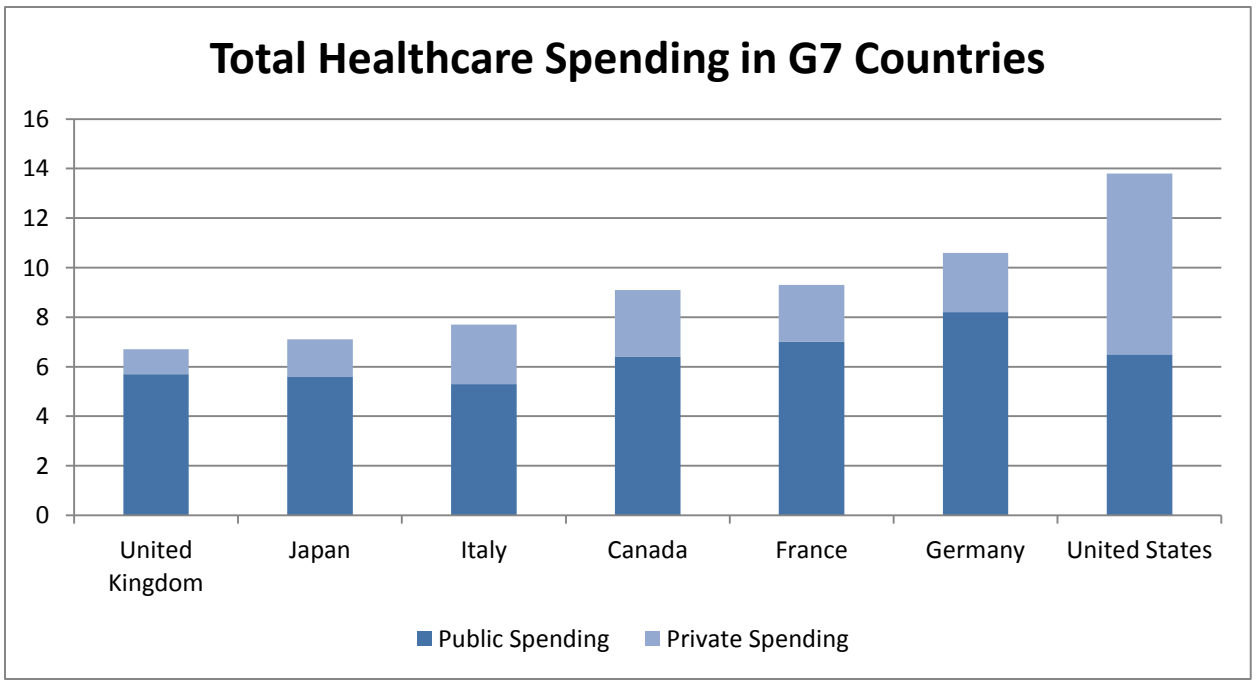

Figure 39: Total Healthcare Spending in G7 Countries

4.3 A Comparison of Selected Countries

We have examined the EMS systems of various countries cities within the United States. Table 6 shows a brief comparison of these EMS systems using 8 categories. The categories include whether or not the Anglo-American model (AAM) or Franco-German model (FGM) is used. The table also evaluates whether or not a country has a public healthcare system, the emergency number(s) used in that country, and what the average response time is for EMS systems in the country. This table also evaluates whether EMTs are available with knowledge of Basic Life Support, Intermediate Life Support and Advanced Life Support.

Table 6: A Comparison of EMS Systems across Selected Countries and Cities

Location	AAM	FGM	Public Healthcare	Emergency #	BLS	ILS	ALS	Response Time (min)
Canada	yes	none	yes	911	yes	yes	yes	9
China	none	some	no	120	N/A	N/A	N/A	5-10 (urban)
Germany	none	same	no	112	yes	no	yes	10-15
Greece	none	yes	N/A	112 116	yes	no	yes	N/A
Hong Kong	yes	none	N/A	999	yes	yes	yes	12
Lithuania	none	yes	no	112	yes	no	yes	15 (urban) 30 (rural)
Portugal	none	yes	yes	112	yes	no	yes	N/A
South Africa	N/A	N/A	N/A	10177 112	yes	yes	yes	15 (urban) 40 (rural)
Sultanate of Oman	yes	none	yes	9999	yes	no	yes	N/A
Taiwan	yes	none	N/A	N/A	yes	yes	yes	4.1-4.9
United Kingdom	yes	none	yes	999 112	N/A	N/A	N/A	8-19
United States	yes	N/A	no	911	yes	yes	yes	10-15
Boston	yes	none	no	911	yes	N/A	yes	5.7-7.6
New York	yes	none	no	911	yes	N/A	yes	6.6
Seattle	yes	none	no	911	yes	no	yes	4.7-7.5

Table 7 compares the strengths and weaknesses of EMS in the countries and cities that were discussed earlier in this paper. Some strengths include highly trained doctors providing pre-hospital care and constant improvements. Motorcycle use for first responders is also among these strengths. Non-homogenous practices are viewed as a weakness because it may require significantly different training for different areas within the country.

Table 7: Strengths and Weaknesses of Selected Countries

Location	Strengths	Weaknesses
Canada	• improving level of care among providers	• uneven service across different provinces and regions inside provinces
China	• discrete EMS framework	• lack of standardization for pre-hospital emergency care personnel • emergency department is combined with pre-hospital emergency care • rural areas lack significant pre-hospital emergency care
Germany	• highly trained doctors provide pre-hospital care	• practices are not homogenous
Greece	• motorcycles	• poor rural coverage, education lacking
Hong Kong	• motorcycles	N/A
Lithuania	• ambulance crews of 2 to 3 people	• lack of ambulance service standardization
Portugal	• dispatchers can advise callers on a course of action	• challenges in meeting the rise in demand for emergency care
South Africa	• Training conforms to the highest standard in the world	• Too many patients • Insufficient funding • lack of equity in resource distribution
Sultanate of Oman	• EMS is growing rapidly	• still in an early stage of development
Taiwan	• rapidly improving since 1990	• no formal training for dispatchers
United Kingdom	• well equipped	• response times lag in remote environments and during times of high demand
United States	• continuing to expand the abilities of all providers	• Paramedics relay findings of ECGs to the receiving hospital
Boston	• emergency preparedness • special operations division	N/A

New York Seattle	• smoke inhalation project	N/A
	• constantly working on improvements	N/A

Figure 40 shows the distribution of countries using the Anglo-American model (AAM) with regards to public healthcare. Of countries using the Anglo-American model, 33% have public healthcare and 67% have private healthcare.

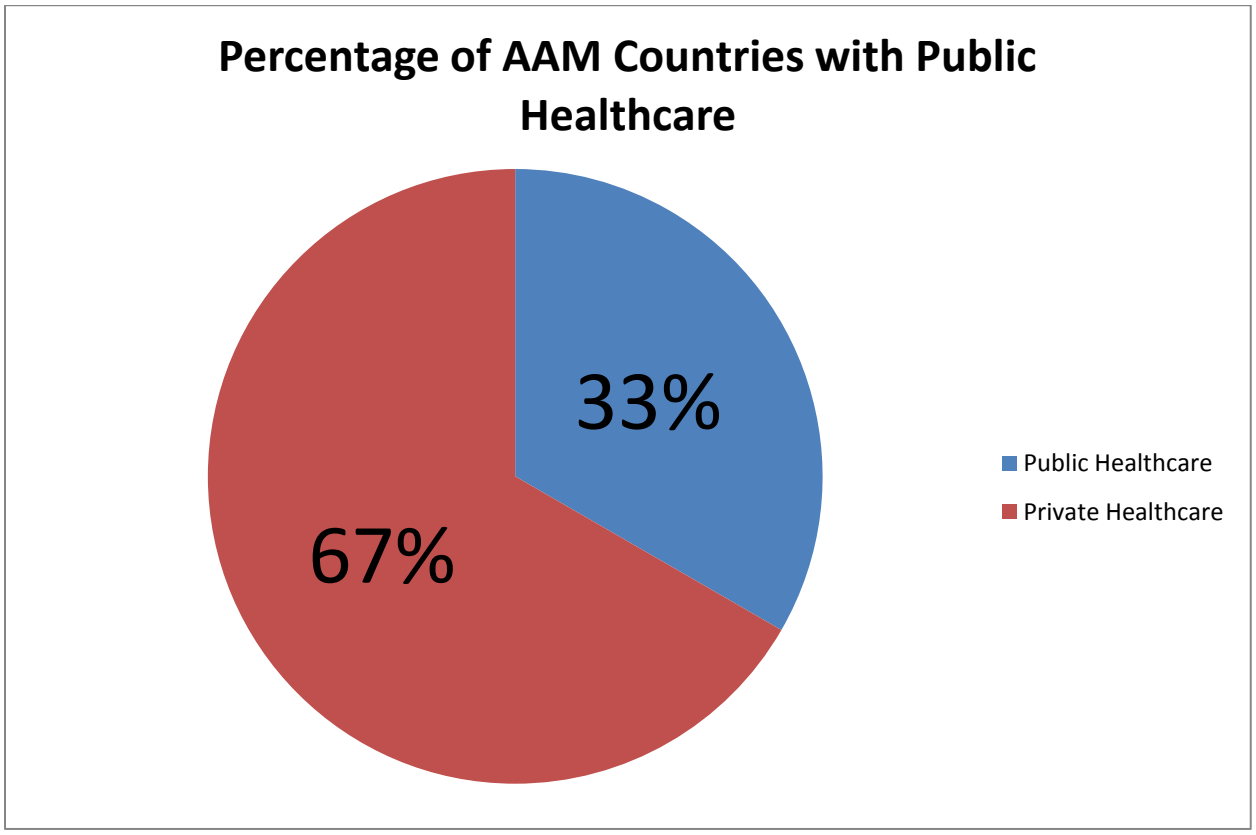

Figure 40: Percentage of AAMS Countries with Public Healthcare

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