"THE ODDS OF SURVIVING A HEART ATTACK MAY BE BETTER IN EUROPE THAN THEY ARE HERE."

Peter Jennings, ABC News

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"If you can't convince them, confuse them . . ."

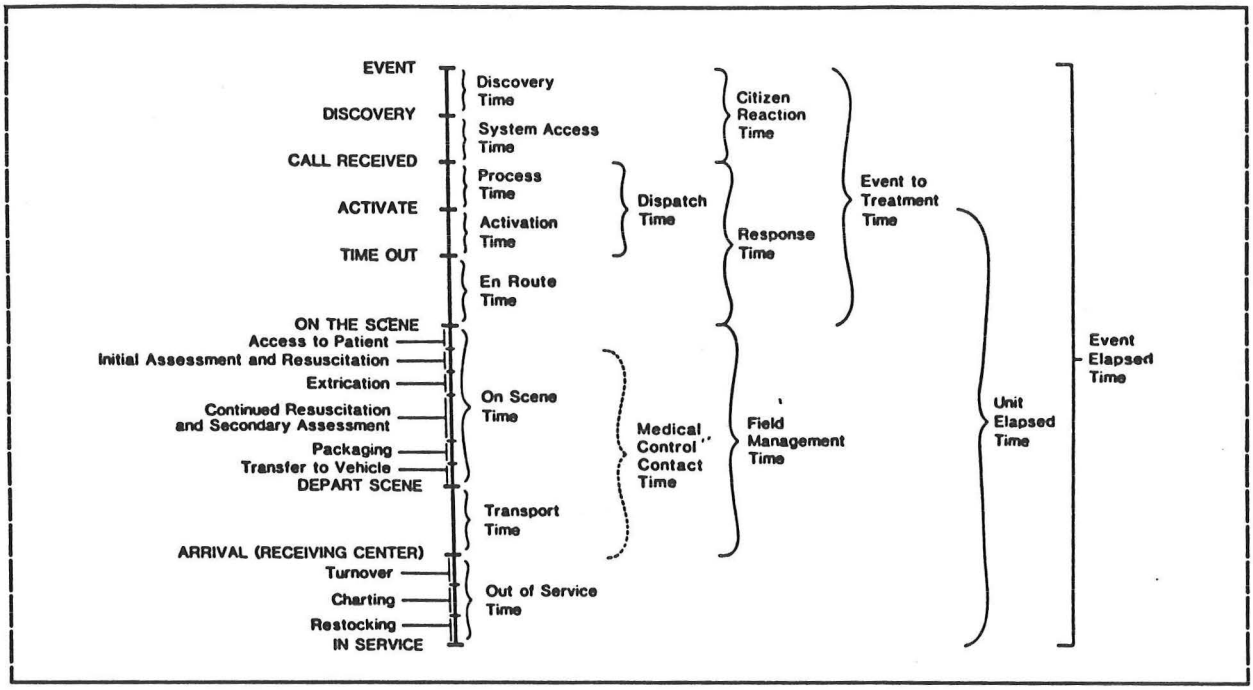
Harry S Truman

On October 16, 1989, Peter Jennings opened a two part segment of the *American Agenda* on the *ABC Evening News* with the statement "The odds of surviving a heart attack may be better in Europe than they are here."[1] As evidence for this comment, Dr. Timothy Johnson of ABC News noted the percentage of Americans with heart attacks who receive thrombolytic therapy was about 5%; while in certain European countries as many as 40% of heart attack victims receive thrombolytic therapy. A panel of experts including Drs. Eric Topol, Eugene Braunwald, Desmond Julian, Robert Breenbaum, Paul Hugenholtz, Peter Sleight and Maarten Simoons pointed out several reasons for the differences. In Europe, physicians are far more aggressive in the use of thrombolytic agents. The fear of side effects does not dissuade the decision in Europe; elderly patients are routinely treated, and patients arriving between six and twelve hours after an AMI are also treated. Other factors playing a role in the difference are the quicker arrival of patients into the treatment systems, earlier treatment by physicians on board ambulances which have thrombolytic agents, and 12-lead electrocardiogram ability.[1] Though we can argue the merits of a very aggressive approach in some patients, the fact remains that, for many reasons, thrombolytic therapy is not having the impact in the United States that it is having in Europe. The use of other agents, such as beta blocking agents that can protect the myocardium, are also more frequently used in Europe.

Although there are many interesting and controversial areas that could be explored, this presentation will deal with the problems of achieving early cardiac care for both the victim of an acute myocardial infarction and the victim of a cardiac arrest. The discussion will be broken into three segments - the patient decision to request care, the pre-hospital delivery of care, and the emergency department delivery of care.

It is important to recognize that there are many steps between the event and the time the patient is admitted to the hospital. Figure 1 reveals the major different functions that occur between the event and the time that the patient has been delivered to the emergency room in the hospital.[2] There are similar functions that must occur in the emergency department before the patient can be treated. Once an event has occurred, it must be discovered. In the case of a cardiac arrest, obviously the patient cannot make the discovery. With a cardiac arrest victim, discovery can be as short as a minute, but it could take hours or longer if the event was not witnessed by a third party. Only about one-half of cardiac arrest victims are witnessed by a third party. In the case of an acute myocardial infarction, discovery is more a matter of recognition that there is a problem, followed by a complex interaction with the patient and those who surround the patient.

EMS TIME / TERMINOLOGY



CITIZEN REACTION TIME

No matter how great a system is organized, the patient must access the system. It is obvious that until the patient or bystanders decide to access the system, nothing can be accomplished. With cardiac patients, the patient may not realize that there is a problem. From the Framingham study and necropsy studies, clinically unrecognized, or silent myocardial infarctions, comprise between 30 and 40% of all myocardial infarctions (Table 1).[3-6] In the Framingham study, serial electrocardiograms revealed a 30% incidence of unrecognized transmural myocardial infarction. Half of these unrecognized myocardial infarctions had absolutely no symptoms when retrospectively questioned, while the other half had symptoms that would be very difficult for the patient to recognize so that the system could be accessed.[3-5] Similarly, it is not possible for a cardiac arrest victim to recognize and access the system; so only one-half of the victims who have a third party witness receive rapid access. Though it might be possible to develop portable monitors to recognize cardiac arrest or ST segment changes and sound a warning to the patient or alert EMS, this approach is very impractical. Thus, one-third of myocardial infarction and one-half of cardiac arrest victims will not receive rapid entry into the health care system, even if all other factors could be controlled. Efforts must be expended to try to improve the system for the remaining patients.

Table 1. Ten-Year Incidence (Rate per 1000) of Myocardial Infarctions Among 2272 Men and 2845 Women at Risk, According to Age and Sex*

	Men		Women	
Age	Unrecognized Infarcts	All Infarcts	Unrecognized Infarcts	All Infarcts
30-34	2.6 (28.6)	12.9	0.0 (0.0)	2.2
35-44	6.5 (17.9)	38.2	2.6 (41.2)	5.2
45-54	16.6 (25.4)	71.2	2.9 (30.5)	13.0
55-64	28.2 (29.1)	107.9	17.9 (34.7)	47.1
65-74	53.8 (41.9)	141.0	21.3 (35.7)	55.7
75-84	60.2 (33.3)	12.8	34.0 (45.5)	128.3
TOTAL	(27.7)		(34.7)	

*Figures in Parentheses Indicate Per Cent of all infarctions that are unrecognized Kannel. N Engl J Med 1984;311:1144.

There have been a number of studies that look at the time from onset of symptoms until patient arrival at the hospital. The mean arrival time in a number of studies has varied from 4.6 hours to 24 hours (Table 2).[7,8,11,13,15-17]

Table 2. Delay Time from Onset of Symptoms until Hospital Arrival

Reference	N	Mean (hours)	Median (hours)
Hackett, 1969[7]	100	10.6	4
Moss, 1969[8]	64	4.6	-
Moss, 1970[9]	160	-	3.5
Simon, 1972[10]	160	-	2.75
Schroeder, 1978[11]	211	7.6	3.5
Alonzo, 1986[12]	1102	-	2.2
Cooper, 1986[13]	111	21-24	6.4
Turi, 1986[14]	778	-	2
Rawles, 1988[15]	450	10	2
Wielgosz, 1988[16]	201	7.5	3.2
Hofgren, 1988[17]	47	19.6	4.8
Leitch, 1989[18]	100	-	2

However, it is inappropriate to use mean times. For example, if nine patients arrive at the hospital within 15 minutes and the tenth patient arrives 48 hours after onset, the mean time is five

hours. Therefore, median times are more important. The median times have generally been between two and four hours with a couple of exceptions.[7,9-18] The two exceptions are the studies by Cooper,[13] which was a study of inner-city African-Americans, and the study by Hofgren,[17] which studied delays in 47 selected patients in a Swedish Hospital. When the data was analyzed to identify the number of patients who delayed more than a given time, 26% to 44% of the patients with an acute myocardial infarction delayed more than four hours.[16,18-19] Hence, the majority of patients arrive at the hospital within four hours of onset of symptoms. However, this time is still very long to achieve the maximum effectiveness of thrombolytic therapy. Also, many patients develop a cardiac arrest within this delay time.

When the reason for the delay is analyzed there are many different factors that play a role. Alonzo[12] has defined six periods of the delay. The first phase is the prodromal period - this is the period of time between the patient's awareness that he/she has a health problem and the onset of acute symptoms. The second phase is the definition period - this is the period of time during which self-evaluation occurs between the onset of acute symptoms and the seeking of advice. The third period is lay consultation - most patients ask their family or friends for advice (93.2% of cardiac patients sought lay consultation prior to obtaining medical help).[12] The fourth period is the medical consultation period - this is the time that the patient calls his/her physician or gatekeeper prior to transport. The fifth period is the travel period - the transport time to the hospital. The sixth period is the hospital procedural period - this is the time from administration and check-in until the patient is ready to be treated.

The prodromal period is a time during which prior education of the patient and family may be of benefit. If a patient is at risk for a cardiac event, the patient could be taught the symptoms and appropriate actions that should be taken if the symptoms occur.

With the onset of symptoms, a period of self-evaluation begins. There are many factors that have been studied to determine those factors which affect the delay time. Table 3 summarizes the results.

The effect of age has been controversial. Many small studies, or studies in which the patients were selected, did not reveal any effect of age on the delay time.[7,9-10,16,20-21] More recent studies with larger numbers of patients have revealed that older patients delay longer than younger patients.[8,14-15,22] The largest study by Alonzo[12]

did not find an effect of age on any of the six time periods, but the study did not evaluate the effect for the total time. Thus, it appears that older age does increase the delay time.

Table 3. Factors That can Vary the Delay Time

Factors that may increase the delay time

- Older age
- Female gender
- African-American race
- Poor socioeconomic condition
- Lay consultation with spouse/friend
- Medical consultation
- Daytime onset of symptoms
- Being at home
- Stable angina
- Diabetes mellitus
- Self-treatment

Factors that may decrease the delay time

- Recognition of cardiac origin
- Severe pain
- Hemodynamically unstable
- Large infarct size
- Education?

Factors that do not change the delay time or are variable

- Day of the week
- Previous myocardial infarction
- Congestive heart failure
- Hypertension
- Known coronary artery disease

Though many studies have not found an effect of gender on the delay time, most of these studies have very few women.[6-7,9-11,16,20-22] Two studies have enough women to make a judgement of the effect of gender on the delay. Turi[14] found that the mean arrival time of women was 3.2 hours, while the arrival time for men was 3.0 hours; however, mean times can be very misleading. Alonzo,[12] in the largest study, revealed that the median time for arrival of women was 47 minutes longer than for men. This was due to a markedly prolonged self-evaluation time in women. One fascinating effect of gender on the delay was when men informed their wives of the symptoms - informing a wife greatly increased delay time.

The effect of race has not been well studied. Most of the studies have been in middle and upper income white males. One study has been quoted as showing that African-Americans have a decreased delay time; however, there were only four African-American patients out of 47 patients.[21] The largest number of African-American patients was in a study by Cooper,[13] in a poor and working class neighborhood in Chicago. These patients had a markedly prolonged delay time, with a median of six hours and mean times of 21-24 hours. However, Turi[14] found no difference between whites and non-whites. The breakdown of the non-whites was not given. Alonzo,[12] in the largest study, found that African-Americans had a longer delay, which was mainly due to younger African-American males trying to find a physician. The studies looking at race as a factor have looked at selected populations; there is insufficient information to draw proper conclusions. There is a need for research into the effects of different cultural groups in obtaining care.

Socioeconomic status has not been a factor in a number of studies.[7,10,16,20-21] However, these studies compared middle and upper income groups and did not contain truly disadvantaged groups. Cooper[13] found that the time was very long in a poor African-American population; but whether this was an African-American cultural effect or an effect of low socioeconomic status can not be determined. The one study that had proper balance between groups showed that low income greatly increased delay time as an independent predictor.[23-24]

Higher education does not have any effect on the delay time in a number of studies.[8-10,14,16,23,25] Lower education levels, less than high school graduation, caused a decrease in delay time in one small series.[21] Education about the signs or symptoms has not influenced delay time in some studies.[19,24] However, these studies have been short-term studies. The longest study in Gothenberg, Sweden did show that a mass education campaign could reduce delay times.[26] It should be noted that anti-smoking campaigns, cholesterol campaigns, and hypertension campaigns did not show any changes in behavior in the three to six months of the early studies. It was usually only after repeated campaigns over years that a change in behavior was seen. Short campaigns can change awareness of a problem, but it takes constant repetition over the years to modify behavior. For this reason, we have little information to understand how behavioral modification occurs in cardiac patients or any understanding of what would be required to modify behavior.

One study of personality traits showed that Type A personalities were slow in labeling their symptoms as cardiac in origin. Once Type A's did recognize that the symptoms were cardiac in nature, they rapidly obtained medical care. Type B personalities more quickly identified their symptoms as cardiac, but they were slow in obtaining medical care. Thus, overall, there was no difference in different personality types.[21]

The clinical status of the patient had an effect on delay time in some patients. Patients who were hemodynamically unstable had significantly decreased delay times.[14,22] Patients with large myocardial infarctions also had shorter delay times.[17] Overall severity of chest pain did not effect the delay.[17,22] However, for those with sudden onset of chest pain, increased severity did decrease the delay time.[7,12,23] Those patients who recognized that their symptoms were cardiac had a shorter delay, while those who thought their symptoms were gastrointestinal or pulmonary had a longer delay.[17]

The majority of studies has shown that a past medical history of cardiac disease either had little affect on delay times[7-8,10,14,16,22] or increased the delay times.[9-10,14] A history of previous myocardial infarction had no affect on delay times.[7-8,11,14,17,22] History of coronary artery disease without infarction or congestive heart failure also did not have an effect on delay times.[10-11] Stable angina and angina with increasing severity prolonged the delay time.[10-11] Diabetes mellitus also increased the delay time.[9,14] Hypertension has had contradictory results, showing both an increase and a decrease in delay time.[7,14,18]

Most studies have looked at the patient's characteristics and ignored the role of third parties associated with the patient. Alonzo[12] has shown in a study of 1102 patients that 93.2% of the patients received lay consultation from a witness. Patients who make the decision by themselves[8,17] have a markedly shorter delay time than those who ask a family member about the symptoms.[7,12] As the most common lay consultants are family members, this causes the median times to increase from two hours to 12 hours in one study. The shortest delay occurs when an unrelated person assists in making the decision. The motivations for these delays by family members, friends, and co-workers are not clear. A common wish to deny the symptoms may play a role. Also, there may be an unwillingness of family, friends, or co-workers to confront the patient and push for early intervention. This may explain why family members and friends allow more delay than co-workers, while strangers allow very little delay.

Consulting a physician can also greatly increase the delay time.[10-12,16,18] The reasons for this delay are varied. Sometimes the physician orders therapy or denies that the patient could be having trouble. Sometimes the call is returned hours later or the office staff fails to have the patient go to the hospital.

Self-treatment by the patient significantly increased the delay time.[10,12,14,17] The patient frequently took over-the-counter medications or prescriptions and waited for the desired response. Delay time was particularly prolonged if the patient felt the symptoms were gastrointestinal and self-treated the symptoms. Americans tended to wait longer if the symptoms occurred during the day,[8-9,12] while British waited longer at night, and it made no difference to Canadians.[16] The weekend has been shown to both increase and decrease the delay time.[8,16] Heavy exertion at the onset of pain has been shown to decrease the delay.[12] Place had some effect on delay times.[12,14,23] Those who had onset away from home and then went home had the longest delay. Most studies did not have many patients who had onset at work, though it appears that patients at the work site had shorter delays unless the patient went home.

These studies have not reevaluated the delays in light of changes that have occurred in health care delivery in the United States. Most of the studies were prior to the advent of thrombolytic therapy and the widespread news media coverage that has been given to thrombolytic therapy by CNN and network news programs. It would be of interest to repeat some of the studies at this time, after the news coverage of the last 18 months. Most of the studies have been of white, middle class males. Therefore, there is a great need for further investigations into delays for women and minorities of varying socioeconomic levels. There is also a need to evaluate more in depth the role of the lay consultant, particularly in different groups. The lay consultant may play a varied role in different ethnic groups, different socioeconomic strata, and with women.

Another area that needs careful consideration is the new role of the gatekeeper for HMO's, PPO's, and other organizations, including the Veteran's Administration and Medicare. "Gatekeepers" are individuals who fill a position designed to determine approval for pre-clearance on elective cases. At present, many patients are instructed by organizations to access the system through the gatekeeper. By phoning the access number for the organization, a gatekeeper decides if the patient should receive immediate care. However, most of the individuals hired as gatekeepers are not knowledgeable about what constitutes an emergency and how the

emergency system works. This gatekeeper system adds a new delay into the system, which can work to prolong the time until the patient receives treatment. A gatekeeper at an 800 number on the other side of the United States may have no knowledge of the local emergency system and only have the phone number of a non-emergency transport service that contracts with the organization. There is no data whether these gatekeepers delay care or in some cases deny care by discouraging the patient from going to the hospital. Careful studies should be performed about the roles of these gatekeepers.

Special consideration should also be given to the use of counter-education. Many organizations have campaigns to stop abuse of different portions of the system. These "use it/don't abuse it" campaigns and refusal to transport or treat the patient programs may be counterproductive, in that they suggest to the patient to be certain that the problem is an emergency before using the services. A patient who is not sure that the symptoms are merely indigestion may be dissuaded from receiving prompt care. This could further emphasize the denial process. The impact of these negative campaigns needs to be evaluated.

Dracup and Moser[27] at the National Heart, Lung, and Blood Institute Symposium on the Rapid Identification and Treatment of Acute Myocardial Infarction: Issues and Answers made several recommendations:

1) Target patients that are at high risk for delay. Older patients, minorities, and patients with chronic diseases are at risk for delay; target and study programs aimed at these individuals.

2) Develop education programs. Educational programs have been shown to increase awareness.[19] However, most studies have not shown a change in behavior. Only in Sweden has a change in behavior been shown.[26] This may be due to the fact that the time of most of the studies is too short to see a change in behavior. Behavior may be easier to change in a country where people utilize mass transit normally and utilize ambulances to take them to the hospital.

3) Emphasize the emergency medical system. Only 12-45% of cardiac patients use the emergency medical system, which may further lengthen the delay.

4) Target programs at the lay consultant. Since 93.2% of patients ask a lay individual for a recommendation, educate the lay consultants of their role through mass media.

5) Educate the families of cardiac patients. This is an area where significant changes could come from a small investment of time and effort. Physicians and nurses should spend as much time educating the family as the patient about symptoms and accessing the system.

In addition, further research into behavioral modification should be attempted.

A key difference between the American system and the European system is the use of the automobile. In the United States less than one-half of the acute myocardial infarctions come to the hospital in an emergency ambulance. In Europe the majority of patients in some countries come to the hospital by ambulance. This may be due to the more common use of mass transportation in Europe. Since Europeans do not drive their automobiles as often as Americans, it may seem more natural to them to call for an ambulance. Also, Europeans tend to look at medicine and emergency services as public utilities. It is possible that the American dependence on the automobile could also add to the delay time, because Americans would tend to wait or call someone to drive them to the hospital.

Physicians may also add to the delays by encouraging patients to go by car or by private ambulance rather than the public system. This is often done out of fear that the public system might not transport the patient to the hospital where the physician practices but will take the patient to another, closer facility or to a facility determined by the protocols or the medical control for the system. All of these factors add to the delays and the under-utilization of the emergency system.

EMERGENCY MEDICAL SERVICES

The development of modern emergency medical services in the United States was sparked in the late 1960's and early 1970's by the occurrence of several different factors. The year 1966 was a pivotal year in the development of emergency medical services. The National Academy of Sciences, National Research Council issued two major policy statements. The first dealt with trauma, the neglected disease.[28] The second contained the recommendation that health professionals learn cardiopulmonary resuscitation.[29] The

development of CPR followed Dr. Kouwenhoven's description of closed-chest cardiac massage in 1960.[30] Also in 1966, the first battery powered defibrillator that was portable (74 lbs) became available. Over the next five years, many governmental agencies developed standards for training, ambulances, and every aspect of pre-hospital care. The American Heart Association developed training programs in resuscitation. The American College of Surgeons developed standards for trauma facilities. The American College of Orthopedic Surgeons developed training courses for a new breed of personnel: the Emergency Medical Technician - Ambulance. These factors pushed the development of emergency medical services from many angles. On the other side, the old system of multiple ambulance companies usually owned by funeral homes was starting to collapse for many different reasons. People began to expect that an ambulance would come to their aid within 10 minutes, not 30 minutes. There was an increased recognition by the public that there was a better system for treating patients.

Between 1969 and 1973, the pioneers in this field - Pantridge from Belfast, Cobb from Seattle, Nagel from Florida and Baltimore, Grace from New York, as well as many others - showed that patients could be resuscitated in the field and could later return to a useful, functional life. Successful resuscitations were demonstrated at large gatherings of people, such as at football games.[31-35] Pantridge and others in Ireland and Britain published data that physicians and nurses on board the ambulances could salvage a number of patients in the field.[36-43] In the United States, Grace also showed that patients could be resuscitated in the field.[44-45] A number of studies, particularly in the United States, demonstrated the effectiveness of telemetry of electrocardiograms, which brought about the establishment of paramedics and nurses providing pre-hospital care without a physician being present.[46-52] Finally, the success of these systems was demonstrated by Crampton, Nagel, Pantridge, Cobb, and others.[33,53-63]

With this information as a basis, a National Conference on Standards for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC) was held in 1973 under the leadership of the American Heart Association and the National Academy of Sciences, National Research Council. The standards were published the next year as the 1974 JAMA Standards.[64-65] Also in 1973, the American Medical Association Commission on Emergency Medical Services published guidelines for developing emergency medical services.[66] These documents became a plan for altering the methods of delivery of pre-hospital care as well as in-hospital care. These two conferences set many important guidelines that controlled the

development of pre-hospital care for the next 18 years. Among the guidelines established were:

1) Advanced Cardiac Life Support training courses were established for physicians and health professionals.

2) Basic cardiopulmonary resuscitation courses were to be taught not only to health professionals but also to all citizens.

3) Emergency medical service systems should be a national goal. These systems should have medical direction and provide a high level of service.

4) Organizations should become active in local, state, and national politics and try to develop these services.

5) Precise standards were developed for what was needed, and methods for cities to establish systems were distributed.

Public support was rallied by a top-rated television series based on the roles of two paramedics from Los Angeles. The same year as these conferences were held Congress enacted Public Law 93-154, Emergency Medical Services Act of 1973, which established a system of federal grants to cities and local areas to develop regional emergency medical service systems.[69] Thus, the pressure on local governments to develop systems was intense, due to the accumulated effect of all of these developments. The final straw was the revision the following year of the Minimum Wage and Hours Laws. Until this time, an ambulance could be on-call. On-call meant that an ambulance team could be continuously on call for 6-1/2 days with only one night off. As an on-call service, it had been assumed that they would only get an occasional call, similar to most physicians. As some states only required one attendant, the economic impact of going from one or two attendants being required to staff an ambulance to ten attendants in order to staff the vehicle 24 hours a day, seven days a week based on a 40 hour work week was substantial. Immediately, every ambulance service was in a state of financial collapse. In every locale, requests for major ambulance subsidies were being sought from local governments. This sudden need for funding combined with all the new standards and political forces caused a revolution in pre-hospital care in the United States.[67-68]

This revolution may have had a number of unanticipated secondary effects. The idea of emergency medicine physicians had been developed during the 1960's, but it had very limited success.

Suddenly there was a need for physicians to become involved in these systems, and the routine specialties had only passing interest in the systems. Further, as systems developed, it became evident that the emergency rooms of the country were grossly inadequate. As one Dallasite stated to me and the administrator of one of our major hospitals, "Why can I be given better care by a fireman in 15 minutes than I received in your hospital in the next nine hours waiting on an ophthalmologist to tell me I might have a heart attack? The fireman told me that in the first five minutes." This type of criticism forced hospitals and hospital staffs to quickly change the staffing of emergency rooms, and the development of the Emergency Department staffed by Emergency Physicians was born. Though there is no known direct connection, it is intriguing to note that several of the younger investigators and instructors in these projects became involved in the thrombolytic therapy developments as well as the antiarrhythmic therapy developments of the last decade. As many of these projects could have come from ideas of these early papers, it is interesting to speculate on the role that EMS has had on medical practice.

Certainly, health care in the United States has been greatly altered by these developments. Though emergency medical service systems can greatly expedite the delivery of patients, they may also complicate the handling of the patient. To understand the impact of these systems on health care delivery, it is important to understand how they are organized and how they operate.

Types of Service -- In the United States there are four major types of emergency medical services that are utilized. These are fire department-based systems, third city service systems, public utility systems, and competitive private systems. There is marked variability in the construction of these systems. Additionally, many areas have marriages of two different types of service.

The fire department-based system probably affects more citizens than any other system, as it is the dominant system in major urban areas. The fire department system uses fire and rescue officers as dual trained personnel who can work with the fire side of the operation as well as the medical side. These systems vary widely. In some cities the fire department provides both the paramedics for the city as well as all transportation to the hospital. In other cities, the fire department provides the paramedics, but transportation is done by a different entity. In still other cities, the fire department may provide both roles as a basic transport service as well as a paramedic service (a two level of service system). Even when the paramedic service and transportation are provided by another entity, the fire department

frequently serves as a first responder. A major advantage of the fire department-based system is the personnel. Employees of the fire service are looking for a permanent career, not a temporary job. Fire personnel receive about a 25-33% higher pay and better benefits than other types of EMS systems. These factors together allow fire services to be very competitive for good personnel. In suburban areas, these individuals provide dual service. In many suburbs of large cities, there are very few fire calls or EMS calls. Firefighter/paramedics can serve two functions simultaneously, taking the appropriate piece of equipment that is needed for the case, as the chance of simultaneous events is very rare. This dual function is very cost effective. However, in the inner city, both services are extensively used and the personnel cannot fill a dual function as easily; though they can rotate from one function to the other to reduce stress. Although these individuals have higher pay and benefits, they do not necessarily cost the city more than other systems. The minimum wage and hour laws allow firefighters to work 24 hours on and 48 hours off for standard pay; extra days off are required so that the average workweek is 52 hours. Other services have a 40 hour workweek. When the differences in hours per week are factored in, the difference between the higher cost firefighters and other services is negligible. Another advantage of the fire service is more extensive training in dangerous environments, such as fire and hazardous materials management and in extrication and rescue. The major disadvantage of the fire department-based system is political. The fire department-based systems struggle for funding with other city services and within the fire departments. Fire departments also live in a very public arena and have to contend with differing goals of governmental leaders, news media, and unions. Also, there is competition within the fire department for resources and, at times, hard feelings between fire suppression and emergency medical services. The leadership may favor one side over the other. Promotion may totally favor one side. The civil service system sometimes makes discipline difficult.

Third city services generally provide paramedic or basic service with transportation. This model is frequently used when the city owns the public hospital, such as in New York City or Austin. Often the third service is operated as a division of the city hospital. The major advantage of this system over the fire department-based system is political. It circumvents intra-departmental politics and gives EMS the same footing as the police and fire department. The major disadvantages are similar to the fire department. Another major cost may be housing and locations for the units. Seldom does a third service system use fire stations for locations. They usually rent apartments from which to

base their vehicles. Extra funds are needed for alert alarms to these apartments. Turnover of personnel is somewhat greater than in the fire service systems. In New York City, many paramedics have applications submitted for police or fire departments and are using EMS to leverage obtaining a fire or police position via the civil service system.

The public utility model is where a single private provider is given a virtual monopoly by the city in exchange for services similar to the arrangement for electrical power or gas. This service provides all ambulance transport including all contracts with HMO's or PPO's, non-emergency transfers, and emergency runs. As the contracts and non-emergency transfers are profitable, the city frequently has to pay less into this system. The advantage of this system is that everyone gets transported for a fee. The tax base does not support the system to the degree of the other models. A disadvantage is that the cost to the patient is often double the other systems and can run as high as $1,200 a call. According to Medicare personnel, cardiac monitoring and intravenous lines are used frequently, as there are extra charges for these services. Service to some areas may not be as good, since the system is operated as a cost efficient business and not as a service. The response time tends to be slightly higher than for the first two systems. As units are not needed at night, very few units may be available at these times. The highest number of units are available at the highest load times. In case of disaster or an unusual number of calls, the system may either not have enough units available to do the job or may have to call in off-duty personnel for the crisis.

The final model is the competitive private model. In this model competing companies either vie for business or are centrally dispatched on a rotating basis. The only advantage of this system is that it tends to be cheap. However, response times tend to be long, and the level of service can be substandard. This model probably has no place in modern systems.

While each of the models can be found in some areas of the United States, in Europe the third city service is the model that is used. In general, the third city service is the only ambulance available; and it provides all of the services. Unlike the United States, the ambulance authority is regional. An example would be that all 400 ambulances in Scotland act under a single authority and are organized as a single organization providing the same services everywhere. The citizen knows that the same service will be provided in the same manner no matter where the victim is.

Public Service vs Business -- Fire department and third city service systems tend to be run as a public service, whereas public utility systems and competitive private systems tend to be run as businesses. The billing systems tend to be quite different. As a public service, the bulk of the service is usually paid by the tax payer, with the individual patient or victim paying only a portion of the cost. Cities vary in how much the citizen has to pay for usage. Some cities charge nothing. Other cities charge non-residents but provide the service free to residents. Still others charge fees. These fees are generally flat fees. Public service systems tend to respond to the victim and obtain only essential information. Thus, most public service systems only obtain adequate billing information for a limited number of patients. On the other hand, public utility and competitive private systems obtain their funding from the patient, with only a small subsidy coming from the city for indigent losses. The bills are itemized with a response fee, a mileage fee for transport, and fees for any service rendered, similar to a hospital bill and physician's bill combined. These systems tend to provide more billable services for a far greater number of patients than public service systems.

When a system is managed as a public service there are a number of differences in service that may not be noticed by the casual observer. A public service system tends to offer uniform levels of service. A public service system will position units so that response time is uniform for most of the citizens of the system. A system operated as a business will operate the ambulances so that the load per ambulance is about the same. For a citizen at the periphery of the city in a more sparsely developed area, a public service system would probably have a rapid response time (5-6 minutes), while a business type system might be considerably longer. Neither the average response times nor the percentage of calls handled within a time period might reveal these differences, but they could greatly effect some citizens. For example, in Dallas the area north of LBJ freeway has a very low number of emergency medical calls. However, this area is quite large. In order to provide a response time similar to other areas in the system, Dallas has a paramedic ambulance, two paramedic fire engines, and mutual aid agreements with Carrollton, Addison and Plano. This area would not have an ambulance in a business type model, as there are not enough total calls to warrant an ambulance. The response time to this area would be 15 to 20 minutes; but since the area has less than 1% of the calls for the system, this long response time would not effect the average response time for the system or make a great impact in the per cent of calls handled in less than eight minutes.

Another difference between the two major approaches is the problem of unusual load. The business type of system keeps the number of ambulances on the road to handle the usual volume of calls efficiently. If there is an unusually high number of calls, there may be inadequate resources. At the time of a rainstorm or disaster, business types of systems may not be able to respond promptly. Public service systems tend to staff for the disaster, so that they have greater flexibility should the unusual arise. Fire department systems often have extra personnel who can be moved quickly from fire suppression to emergency medical services should the need arise.

Business types of systems can respond more quickly to changes in technology. Since most new technology can be billed, a business type of system would add a new drug or technology to the service quickly. As public service systems are a part of the governmental bureaucracy, it is difficult to add new technology. If a new service is very advantageous it takes two years minimum to add it to the service. It takes six months of education to convince the fire service or others of the need for the new technology. Once convinced of the usefulness, it must be added to the city budget. The departmental budget request must be submitted internally at least six months prior to the budget year. It must then compete against the priorities within the ambulance division. It then must compete against other priorities within the fire department. It then must compete with police priorities before an assistant city manager. It then must compete against all other city services before the city manager. Then it can be submitted to the city council, where it competes against the various agendas of the elected officials. It is a difficult, uphill battle to obtain new technology. Once it is approved, it then takes months to prepare specifications for bids, bids to be received, and then justification of the vendor selected. Unfortunately, bids on inferior products can be received. If this should happen, then considerable time would have to be taken to prove that this low bid does not meet the specifications. A few years ago the low bid for a defibrillator was from a small, unknown manufacturer. This defibrillator did not have a synchronizer. The defibrillator did not have an output jack to send an ECG over the radio. Also, the defibrillator did not have radio frequency shielding; so when the radio was used or the defibrillator was in the back of the ambulance, the ECG tracing would not appear on the scope. The defibrillator was not water resistant. The controls were on the top of the defibrillator, where they could be easily broken in the pre-hospital environment. Finally, the battery was not adequate to handle the volume of calls that the system had per day, and the battery was not changeable. Clearly, this was a device that could

not be used on an ambulance. However, it took weeks to get the bid thrown out as non-compliant. Business types of systems can quickly obtain the equipment that they wish.

Public service systems are in a fishbowl. Public service personnel more freely admit mistakes and, as most records are open records, the news media can freely criticize the system. Business types of systems tend to keep mistakes internal; and since they are privately owned, the open records rules do not apply. Some business systems have better quality control, as they are not under governmental immunity as a public service system is. Most business types of systems are willing to pay for quality control systems; it is difficult to obtain funds for quality control in public service systems. In Europe ambulance service is a public service.

Levels of Service -- In the United States there are several different levels of service provided by emergency medical services. The two most common levels of service are the EMT-A, Emergency Medical Technician-Ambulance (or Basic) and the EMT-P, Emergency Medical Technician-Paramedic, commonly called paramedic.[67-68,70-72]

An EMT-A has between 81 and 176 hours of training in basic first aid skills; the exact number of hours depends on the date of certification and varies from state-to-state. An EMT-A is trained to provide CPR, oxygen therapy, and other types of first aid skills. Most ambulance personnel are EMT-A's.[67-68,70-72]

The EMT-P, or paramedic, has more extensive training, varying from 400-2000 hours. Paramedics can provide advanced therapy including defibrillation, administration of certain cardiac drugs, infusion of intravenous fluids, and endotracheal intubation. Though EMT-P's comprise a minority of ambulance personnel on a national basis, this level makes up the majority of personnel in cities. As most Americans live in cities, the majority of the pre-hospital patients probably receive their pre-hospital care from paramedics.[67-68,71-72]

There are other levels of pre-hospital personnel which vary from state-to-state. Many states have an EMT-I, which is an intermediate form of EMT. An EMT-I may be able to infuse intravenous fluids or intubate a patient and may be able to give a few drugs, such as 50% dextrose. The EMT-D, EMT-Defibrillation, is another certification level found in some states. The EMT-D initially used a manual defibrillator with a minimum amount of training. Recently, the development of automated defibrillators has allowed major expansion of this concept. Automated defibrillation can be taught with a four hour course and can be

used by EMT's with few problems. Automated defibrillators may be less expensive than standard types of defibrillators.[73-81]

Emergency medical service crews can be augmented with First Responders. These are personnel who will arrive first at a scene and initiate treatment such as CPR and even automated defibrillation. They may be volunteers, firemen, police, security, or other types of personnel. First Responders can provide earlier defibrillation, thus increasing survival.[67-68,71-72]

The majority of the ambulance personnel in Texas and in the United States are EMT-A, or the basic trained individuals. As shown in Table 4, there are five times as many EMT-A's as paramedics. In Texas, First Responders are what is called an ECA or Emergency Care Attendant. ECA's are trained with 40 hours of training; unlike other states, ECA's are allowed to staff ambulances. In Texas, paramedics comprise 12.8% of the ambulance personnel. Nationally, paramedics comprise 9.6% of ambulance personnel.[70] Thus, Texas is slightly above the national average. However, the Dallas area fire departments have 890 of the 4,466 paramedics in Texas. Other cities such as San Antonio, Houston, Austin, El Paso, and Ft. Worth have large numbers of paramedics. Outside of the cities most personnel are ECA's or EMT-A's. Texas does not have an EMT-D (defibrillation) grade, though all levels of personnel may use automated external defibrillators as long as they have had four hours of training and are operating under the authority of a medical director.

Table 4. Prehospital EMS Providers for Texas and United States

	Texas	USA
Population, 1986	16,685,000	241,078,000
First responders	9,857	114,093
EMT-A	19,230	363,691
EMT-D	0	5,254
EMT-I	1,316	17,733
Paramedic	4,466	41,295

Congress of the United States, Office of Technology Assessment. Rural emergency medical services (special report). OTA-H-445, November 1989.

It is time to consider revising the minimum standards for personnel manning ambulances. It may be reasonable for the minimum level of training for an emergency ambulance transporting cardiac patients to be an EMT-D with an automated defibrillator. Wherever

it is economically and logistically feasible, EMT-P's, or paramedics, should be utilized. First Responders with automated defibrillators should be added to a paramedic-based emergency medical service system to act as a critical care team in the field. The use of First Responders with automated defibrillators with a basic system of ECA's or EMT-A's has not been studied but makes intuitive sense.

In Europe, paramedics are extremely rare. Most ambulances are staffed by the equivalent of the EMT-A's, though they generally have more training. However, in Europe, ambulances with physicians on board are frequently dispatched to critical cases; a nurse may also be included. If a call comes in that is obviously cardiac, then a physician is frequently sent on the ambulance. Similar staffing is used for major trauma.

Access -- Time is a critical factor for the cardiac patient, both from the standpoint of cardiac arrest and from the potential administration of thrombolytic therapy. Thus, it is essential for the patient to obtain quick entry into the health care system. The first step is for the patient to make the decision to access the system. As most patients are with someone else at the onset of symptoms, the decision to access the system is a combined decision. It has been shown that when the other person is a co-worker the time to access is very short. The time is longer if the other person is a close friend, and it is even longer if the other person is family or spouse. Though attempts to reduce the time through public education have been successful in Europe, they have not been successful in the United States.[19,26] Greater information is needed to be able to understand and alter this behavior.[27]

It is essential that access to emergency medical services be uniform and quick. A single, nationwide emergency number for emergency services - fire, police, and medical is essential; and the number should be the same - 911. Unfortunately, only two states, Delaware and Maryland, have statewide 911 systems. However, eleven other states, including Texas, have passed mandatory legislation to have 911 statewide in the next five years. The establishment of 911 as a national standard is essential in order to provide quick and uniform public access.[70]

There are two types of 911 systems available. One version is the phone number 911 that connects the caller with an operator or dispatcher. A more sophisticated version is the enhanced 911 system that has automatic identification of the caller's telephone number and address. This latter variety has great advantages when dealing with an emergency situation in which people may not be able

to communicate calmly the information required to obtain an emergency response. An enhanced 911 system should be a goal.

Table 5. Emergency Access Number by State

	Legislation mandating 911	% of Population Covered by 911	7 digit number	multiple numbers
Alabama	no	60	40	0
Alaska	no	85	10	5
Arizona	yes	90	?	?
Arkansas	no	10	70	0
California	yes	90	?	?
Colorado	no	80	0	20
Connecticut	yes	65	35	0
Delaware	no	100	0	0
District of Columbia	yes	10	?	?
Florida	no	89	?	?
Georgia	no	60	100	?
Hawaii	no	95	5	0
Idaho	no	50	45	5
Illinois	no	50	45	5
Indiana	no	40	45	5
Iowa	no	?	?	?
Kansas	no	70	30	0
Kentucky	yes	33	10	57
Louisiana	no	?	?	?
Maine	no	50	50	0
Maryland	yes	100	0	0
Massachusetts	no	39	0	61
Michigan	yes	45	?	?
Minnesota	yes	90	10	0
Mississippi	no	50	50	0
Missouri	no	65	35	0
Montana	no	?	?	?
Nebraska	no	90	0	10
Nevada	no	80	10	10
New Hampshire	no	30	5	65
New Jersey	no	27	0	73
New Mexico	no	70	15	15
New York	no	65	10	25
North Carolina	no	31	55	14
North Dakota	no	32	68	0
Ohio	yes	30	70	0
Oklahoma	yes	7	93	0
Oregon	yes	90	5	5
Pennsylvania	no	45	40	15
Rhode Island	yes	?	?	?

Table 5 (cont). Emergency Access Number by State

	Legislation mandating 911	% of Population Covered by 911	7 digit number	multiple numbers
South Carolina	no	35	30	35
South Dakota	no	60	25	15
Tennessee	no	50	30	20
Texas	yes	20	60	20
Utah	no	80	10	10
Vermont	no	15	85	0
Virginia	no	79	16	5
Washington	no	80	20	?
West Virginia	no	15	25	50
Wisconsin	no	41	30	29
Wyoming	no	90	4	6

Congress of the United States, Office of Technology Assessment. Rural emergency medical services (special report). OTA-H-445, November 1989.

Though the idea of a 911 system was developed in the United States in the 1960's, progress has been slow. In Europe the response has been more complete, with several European countries having a single emergency number such as 119 or 0611 as national numbers. Dallas has an excellent enhanced 911 system.

Dispatch -- Centralized dispatch is required to provide fast and efficient emergency medical services. With a centralized dispatch, a quick and efficient response can be obtained by insuring that the closest available unit or units would respond. This is particularly important in areas where there are multiple agencies providing similar or the same service. The dispatcher should be trained to determine what services are needed. The need for centralized dispatch can also be illustrated by the requirements for a cardiac arrest victim. A cardiac arrest victim needs quick and efficient CPR as well as defibrillation. Two individuals on an ambulance cannot quickly and efficiently handle a cardiac arrest victim; but with centralized dispatch of an integrated system, a fire engine or other First Responder could be sent to provide CPR and early defibrillation with an automated defibrillator, while the paramedic crew can provide the drug and other advanced therapy required in a rapid, efficient manner. For dispatch to be effective, dispatchers need to be trained. There is a need for EMD's, Emergency Medical Dispatchers. These dispatchers can determine the types of equipment and personnel required for the problem and even provide first aid via the telephone. It has been shown that untrained telephone callers can be told how to do CPR

until the system can respond. Thus, trained personnel can greatly improve the quality of dispatch.[82-89] Efficient, centralized dispatch with trained dispatchers should be a national goal.

Many European countries have trained dispatch systems that can determine the level of response. Dr. Rudy Koster has shown me the system that has been developed in the Netherlands during the last two years. The universal emergency number is 0611. Once the dispatcher has been reached, the dispatcher quickly inquires into the nature of the problem. If the victim is not the caller, the dispatcher asks first if the victim is conscious and can talk. If the answer is affirmative, the dispatcher double checks by asking if the victim is breathing. If the answers to the first two questions are negative, a rescue officer is sent by motorcycle with an automated defibrillator. An ambulance with a physician and critical care team is also dispatched. The patient's general practitioner is notified to respond, if possible. On the other hand, if the complaint seems to be minimal, the patient is sent to his general practitioner. In Dallas, dispatchers have no specialized medical dispatcher training. They are trained as fire department dispatchers.

Transportation -- According to a Congressional report there are more than 12,000 ground and 200 air ambulance services in the United States. The number of vehicles per service is not known. The number of vehicles vary from one to more than 100 ambulances per service. Most of these services have the ability to provide safe transportation.[70] Though the majority of the population appears to have access to adequate transportation, the distribution and quality of the service provided may vary. Factors affecting the quality and distribution include long distances between services, competing ambulance services, barriers to transportation such as mountains and lakes, economic issues, and environmental conditions. There is a need in the future to develop appropriate distribution of the services and to improve the quality of some of the services in a cost effective manner.

Public service systems frequently have very few ambulances and do not transport all of the patients that call for assistance. In Dallas 41.9% of the calls for assistance are transported. There are no sick or injured patients 17.0% of the time. The not sick or injured is frequently an automobile accident called in via cellular phone as a major accident with people trapped, and when the system responds there is minor damage and no injuries. However, there is a significant number of patients not being transported. Most American systems have one ambulance for 35,000 to 40,000 people.

European systems have one ambulance per 12,500 population. In Dallas there is one ambulance for 47,000 population.

Regional Planning -- Regional plans should be developed to determine the manner of delivering emergency medical services. These plans should integrate the uses of various resources including First Responders, ground ambulances, fixed wing aircraft and helicopters to provide the efficient and safe transport of patients to the appropriate facility.

The regional plan should set out the appropriate criteria of how a patient is allocated to a particular hospital. Many systems require that the patient is taken to the closest facility. Some systems take the patient to the closest appropriate facility. Other systems take the patient to the hospital of the patient's choice, as long as the system has the needed resources to provide transport to a further facility and the patient is stable.

These policies must be evaluated as to how they affect the delivery of optimal care to the cardiac patient. Transport to the closest facility may not be appropriate if the patient has been cared for at another facility which has an extensive medical record as well as a physician who has a doctor/patient relationship. With the specific knowledge of the anatomy and other medical history, the physician may have already decided upon a plan of therapy should the patient enter with prolonged chest pain. The patient's physician may have decided to use thrombolytic therapy in one patient while planning to take another patient to angioplasty or surgery. Thus, the closest facility might not be able to provide optimal therapy. On the other hand, the closer facility may be able to provide care more quickly. These competing concepts must be considered in the planning process. A reasonable approach might be to transport the patient to the facility where the patient's physician or records are located, if the patient is stable to handle the additional transport time. Transport to the closest facility is a policy used in some areas as a cost reduction measure, since the vehicle and crew can return to service more quickly. Another reason for transport of the patient to the closest facility is the crew's anxiety over the patient developing a complication. The crew feels that the faster they deliver the patient, the less the chance for complications.

Hospital crowding should also be considered in the plan. Is it appropriate to take the patient to the closest facility or the facility of the patient's choice if there are no intensive care beds available? This is a significant issue that will affect how cardiac care is to be delivered. These problems must be addressed

in a regional plan which takes into account the medical and emergency medical service communities.

In Europe there is regional planning, as most countries have a socialized system that allocates patients, hospitals, and resources. The Dallas area does a better job of regional planning than most areas of the United States. There is a history of hospitals working together in Dallas which has allowed more planning than the confrontational approaches in other areas.

Medical Direction -- Since paramedics function under the delegated authority of a physician, medical direction of emergency medical services is essential to provide good care. Strong medical direction must be developed for all emergency medical services, regardless of the level of care being provided, to insure that patients receive appropriate care and are taken to the appropriate facility. This includes setting patient care standards through protocols. It also includes effective physician or physician directed input via radio/telephone communications where indicated. More physician involvement will be needed in the future.[67-68]

Categorization of Hospital -- Hospitals must be categorized according to their capability of taking care of different types of patients. These categorization schemes should be used in the regional planning process. The emergency medical service personnel should be aware of the categorization and then triage patients accordingly. The American Medical Association in cooperation with other organizations developed categorization schemes for hospitals for cardiac care.[90] There is a need in the plan to categorize hospitals, so that the system can transport the patient to the appropriate facility. This plan recognizes three levels of facilities - primary, secondary, and tertiary.

A primary cardiac facility is one that can provide 24-hour-a-day immediate resuscitation of the patient with basic and advanced cardiac life support but it lacks intensive care capability to provide long term care of the cardiac patient. If the patient can be stabilized in this facility, then the patient can be transferred to a higher level as soon as possible.[90]

A secondary cardiac facility is one that not only can provide basic and advanced cardiac life support but also can provide intensive care capabilities. This center should have the ability to insert cardiac pacemakers, administer thrombolytic therapy, and provide adequate intensive care capability. This level of facility can probably handle 85% of all of the acute cardiac patients.[90]

A tertiary cardiac facility has all of the above capabilities but also has cardiac catheterization, angioplasty, and cardiac surgery. The tertiary facility should be able to handle any type of cardiac problem and provide definitive care for the patient. This facility could primarily receive the patient or have the patient transferred to it from another facility. Only about 15% of patients need to be brought to this facility initially, unless it is the closest facility.[90]

A patient should be taken to a primary facility only when a secondary or tertiary facility cannot be reached within a limited amount of time (15-20 minutes?). The only patients that should be brought to the primary facility are patients who are so unstable (i.e. cardiac arrest) that the additional transport time to a tertiary or secondary facility is not warranted. Emergency medical service capabilities should also be taken into consideration. The region should develop a plan to categorize facilities and to determine the circumstances in which a patient is taken to a primary, secondary, or tertiary facility, if they are available in the region.[90]

There are areas that are so rural that the only possibility is to take the patient to a primary facility. That primary facility may be more than 30 minutes or even several hours from any secondary or tertiary facility. In these areas a detailed plan for how the patient shall be transferred is needed, so that any delays can be minimized. The primary facility, in certain circumstances, might give thrombolytic therapy while waiting on transport. Consideration of the use of helicopters should be entertained wherever possible in these types of rural settings. Fortunately, the number of people in these extremely rural areas is very small. Most rural populations are within 15 to 20 minutes of a secondary hospital by ground or air.

Potential New Therapies for Cardiac Patients -- Early defibrillation programs have been shown to be of benefit in the United States. Several different models of these programs have been attempted. The first such programs were using emergency medical technicians to provide early defibrillation with manual types of defibrillators. These personnel were trained initially with 120 hours of basic rescue techniques. They were then taught how to recognize ventricular fibrillation on a monitor and to deliver a defibrillation shock. These programs proved to be successful in several different areas and showed that highly trained personnel were not needed in order to defibrillate a patient. The development of automated defibrillators also increased the ability to defibrillate the patients. These devices

have paste-on electrodes and are activated by pressing one or more buttons. Each of these devices has a system to determine that the electrodes are properly attached. The ECG is then evaluated. If the pattern shows ventricular fibrillation as well as the absence of any other type of cardiac rhythm, then the device can shock the patient. The fully automatic varieties may be activated once the electrodes are attached by pressing an "on" or "start" button. The device then analyzes the ECG and if ventricular fibrillation is present, charges the defibrillator, shocks the patient and then reanalyzes the rhythm. The energies are even selected by the device. The semi-automatic types of devices usually have a "start analysis" button. When the device is charged, the operator must press a "shock" button to deliver the shock. The development of these devices has allowed a number of uses in less highly trained personnel. One idea was for families of high risk patients to be trained. This has been attempted in the United States, but it has not met with success. It has been difficult to identify the patients who need the device so that the family can be trained. Even when the patient has a cardiac arrest, the trained member of the family may not be present or the arrest occurs while everyone is asleep. Another method has been to train different types of first responders to use these automated devices.[73-81]

In Dallas we use firemen to act as first responders with automated defibrillators. To evaluate whether improvements in survival could be made with earlier defibrillation in an urban paramedic system, a study was begun in 1985 using automated defibrillators which detect ventricular fibrillation and advise or provide defibrillation. The design was to place these devices on fire engines in districts where there were no paramedics and ambulance arrival was delayed after fire engine arrival. The automated devices were used in 169 patients. The average response time in the system for the fire engine and ambulance were 4.00 and 4.97 minutes, respectively, but in the districts studied the fire engine was on the scene for more than two minutes before the ambulance 62.7% of the time. Of the 169 patients, 74 had ventricular fibrillation, 89 had asystole, and 42 had electromechanical dissociation. Of the 74 patients with ventricular fibrillation, 72 were shocked by the device; the two patients not shocked had fine ventricular fibrillation. No patient with asystole, electromechanical dissociation, or a perfusing rhythm was shocked. When individual analyses were examined, the machine correctly shocked or advised shock in 104 of 115 episodes of ventricular fibrillation. Thus, the sensitivity of the device was 90% for all episodes of ventricular fibrillation and 97% for patients with ventricular fibrillation. The difference between the two values was due to the fact that with fine ventricular

fibrillation the device would not recommend a shock for two or three times, but on the third or fourth attempt, it would shock the patient. The specificity of the devices was 100%. Twenty-one patients were initially admitted to the hospital with perfusing rhythms, and 19 were long-term survivors. In a control group of 200 patients from the same districts on whom automated defibrillators were not used, the initial resuscitation rate was 5%, with a long-term survival of 2.6%. With the automated defibrillators, the initial resuscitation rate was 12.4% with a long-term survival of 11.2%. Therefore, the judicious use of automated defibrillators can increase the short- and long-term survival in cardiac arrest even in an urban system with rapid delivery of paramedic care.[91]

Though the idea was started in Dallas, automated defibrillators are only on 32 of the 55 fire engines in the city due to budgetary constraints. Several other cities in Texas such as Houston, San Antonio, and Ft. Worth have them either on all fire engines or on order to be placed on all fire engines. About 10,000 of these devices have been sold in the United States, while only about 1,000 have been sold in Europe. It is interesting to note that Scotland bought 400 and placed one on every ambulance. Similarly, Australia has placed them on every ambulance in two provinces.

Advances in technology raise a number of questions about the level of service to be provided on ambulances. The development of 12-lead electrocardiograms with computerized interpretation that can be transmitted by cellular phone or radio allows these ECG's to be obtained in the field. This might be useful to the receiving hospital. If the receiving hospital has a 12-lead ECG that reveals an acute myocardial infarction along with appropriate history, the personnel in the hospital can be ready to give thrombolytic agents, beta blocking agents, nitroglycerin, or other agents as soon as the patient arrives - rather than being delayed while the hospital obtains that data after arrival. This may be of benefit.

Studies in the Netherlands and Israel have shown that survival can be increased by giving thrombolytic therapy on the ambulance. These studies were performed by physicians who staff the ambulances.[92-93] Four other studies in Europe have been verbally reported showing benefit, including one with non-physicians giving the thrombolytic agent. In the United States, where the care is provided by paramedics, it has not yet been shown to be effective and safe. Large scale studies are currently underway in Seattle (the MITI trial) and other cities to determine the safety and effectiveness of these agents on an ambulance.[94]

Even if the effectiveness and safety of thrombolytic therapy can be proven, cost may present a significant problem. Reimbursement for ambulance service is very poor; many urban areas receive reimbursement for only 10-50% of their costs. The high costs of thrombolytic therapy will require that a new funding mechanism be developed to cover these costs. The ability to obtain Medicare, Medicaid, and third party insurance reimbursement is essential and must be sought.

The use of aggressive pre-hospital therapy for acute myocardial infarction may increase the medicolegal risk for the emergency medical service system. Many states have limited liability laws for pre-hospital providers; these may be in jeopardy with more aggressive management. Though more aggressive management may increase the salvage of patients and their myocardium overall, some patients will have worse outcome, raising the risk for potential litigation. The legal consequences of this type of therapy must be evaluated, and planning must take into account the medicolegal risks.

Costs -- There will be significant costs for this additional training, equipment, and improvements to the pre-hospital system. Improvements in the system will require changes in funding. These changes in funding might require state or federal funding, which might be difficult to obtain at the present time. However, when put into perspective, the new equipment is relatively inexpensive. In Dallas a fully stocked ambulance costs about $100,000. To acquire and maintain the ambulance with supplies and service for one year costs $113,731. As an ambulance in Dallas has a two year life, the cost per year for equipment and supplies and service is about $70,000 (staffing of the vehicle is an additional $376,654 per year). The specialized equipment for new therapies costs about $17,000 and has an eight year half-life. With supplies and service, the amortized cost of these new technologies is $3,000 per year per ambulance for the equipment. The costs of new equipment is no more expensive than replacing the current 10-year-old equipment. However, the costs of the drugs may be significant. If thrombolytic agents such as tPA or APSAC were used, the cost of these drugs would be prohibitive with the present system.

Recommendations -- If thrombolytic therapy and other advanced technologies are to become as effective as possible, major changes in the delivery of emergency medical services are essential. To accomplish these goals, the following recommendations were made by Michael P. Wainscott, M.D. and this author:[95]

1) Enhanced 911 should be a national goal within five years.

2) EMT-D (defibrillation) should be the minimum level of training for emergency ambulance personnel.

3) Paramedics should be utilized wherever possible.

4) Regional emergency medical service plans should be developed with specific plans for care of the cardiac patient.

5) Medical directors should be required for all emergency medical service systems.

6) Triage of patients should be defined (patient choice vs. closest facility).

7) Methods of reimbursement for emergency medical service systems must be established.

EMERGENCY DEPARTMENT

Even if all the problems with patients and with the emergency medical service system can be resolved, there are other problems after arrival at the hospital which cause delays in the time to thrombolytic or other therapies. This delay time in the emergency department is due to many factors. The method of organization of the Emergency Department has been responsible for some of the delays. Patients with chest pain generally go through the registration system and are evaluated by a nurse who may order an ECG. They are then evaluated by a physician who is caring for other patients. In many studies the average time after entry into the system has been two hours. In the Seattle studies the time before pre-hospital information was provided was 144 minutes. When information was obtained in the pre-hospital environment, the delay time was reduced to 72 minutes.[94] Seattle has shown that merely by obtaining the ECG in the field and transmitting the ECG to the hospital and allowing the decision for thrombolytic therapy to be made by those physicians present in the Emergency Department on patient arrival to make the decision, the time to thrombolytic therapy can be reduced by 73 minutes in a comparative evaluation.

It is obvious that if thrombolytic therapy is going to have its best effect the patient must be handled in an expeditious manner. The present organization and overload in many of the Emergency Departments of our hospitals have to be examined. The delay times in hospitals vary greatly; however, in major hospitals it appears there are substantial delays. Perhaps the chest pain patient should be treated as the major trauma patient is handled.

When a patient comes into the Emergency Department with major trauma, the patient bypasses the registration system. The patient is immediately taken to a resuscitation room and a rapid assessment is done, while others start intravenous fluids and obtain blood specimens in an organized manner, so that all the evaluation is done very quickly in a priority-type approach. The same could be done with the patient with chest pain. If a patient enters with chest pain, the patient could be taken directly to a cardiac room without pre-registration. Once in the cardiac room a team could quickly evaluate the patient, start the intravenous fluids, obtain the ECG and laboratory specimens and be ready to start thrombolytic therapy.

A system should be designed so that there is no delay in giving thrombolytic therapy once the decision had been made to give the drug. Private physicians should empower those present in the Emergency Department to give the agent if they are not present. Waiting for the admitting physician to come to the Emergency Department is responsible for major delays. Though no one system is perfect, each hospital should look at itself to determine how it can rapidly administer these agents.

Another consideration is transmission of a 12-lead ECG from the ambulance to the Emergency Department. Seattle has reported that the physician at the hospital having the history of chest pain and an electrocardiogram showing the infarction greatly decreased the time before administration of thrombolytic therapy. It might also give some time for notification of the admitting physician, so that the admitting physician in some cases could be available when the patient arrives in the Emergency Department. These changes should be considered.[94,96-97]

A public campaign was successful in reducing the delay time in Gothenberg, Sweden from three hours to two hours.[26] In this study there was a 10% increase in the number of patients with acute myocardial infarction arriving at the hospital within two hours of the onset of symptoms. However, the number of patients without myocardial infarction increased from an average of 9.8 per day to 13.1 per day. Similar increases have been seen with other educational programs.[19] This increase in patients caused more patients to be admitted to the hospital with the use of intensive care beds for ruling out disease. Though the program was very beneficial for some patients who were admitted and treated earlier with disease, there was a cost to be considered for those without acute myocardial infarction. In the United States with our nursing shortage and lack of an adequate number of intensive care beds, this increased utilization may cause more patients to be cared for

outside the intensive care unit. This is a significant cost that is difficult to determine. Dr. Lee Goldman has calculated the worst case scenario and found that the cost could be up to $1,000,000 per life saved without changing the present organization of the Emergency Department and the criteria for admitting patients to the hospital.[98] Thus, careful planning needs to be done on the implementation of any major program.

In Europe the Emergency Department and the intensive care units are not as overloaded as in the United States. A significant difference is trauma. In the United States, trauma represents one quarter of the load on the Emergency Department and the pre-hospital system. In Europe, trauma makes up only about 10% of the load. This is partly due to the fact that more non-trauma patients are transported in their system, but it is also due to a far lower incidence of significant trauma. In spite of no speed limits on the autobahns, traffic accidents with serious injuries are fewer in Europe, probably because of very strict driving-under-the-influence laws. As alcohol is related to most traffic accidents in the United States, this causes a considerable carnage. Another major difference is the absence of gun shot injuries. Murder is not common in Europe, and the use of guns is very rare, except by terrorists. This lack of trauma allows the emergency systems of Europe to concentrate on the cardiac patient. Hospitals in Europe generally have set policies on the administration of thrombolytic agents, so that there are no procedural delays.

CONCLUSIONS

The treatment of the cardiac patient is reaching a point where major changes may occur in the near future. It is obvious that several organizations are interested in the process as evidenced by recent publications.[96,99] This interest is similar to that generated in 1973 with cardiac arrest. Recently the National Institutes of Health held a conference to make recommendations concerning the issues. Next February the American Heart Association, in conjunction with many other organizations, will hold a conference to revise the teaching materials for CPR and Advanced Cardiac Life Support with a major emphasis on thrombolytic therapy and the problems that have been discussed. This combination can greatly change the way health care is delivered, similar to what happened in 1973.

The National Heart, Lung, and Blood Institute of the National Institutes of Health is developing a new program called the National Heart Attack Alert Program. The proceedings will soon be published that establish the background and some of the plans for

this program.[100] The major recommendations for this program are listed as follows:

GROUP I: TREATMENT-SEEKING BEHAVIOR AMONG THOSE WITH SYMPTOMS AND SIGNS OF AMI

1. Information about symptoms and signs of AMI and recommendations for action should be enhanced and reinforced within current CPR courses of the American Heart Association and the American Red Cross.

2. Educational programs for triaging AMI patients should be targeted to physicians and their office and clinic staff.

3. Research is required to: measure sources of variation in treatment delays; most effective methods of triaging AMI from "usual sources of care" into emergency departments, or Emergency Medical Services (EMS), symptom severity and presentation across diverse groups such as women, minorities, lower socioeconomic strata; impact and costs of educational efforts; most effective public education strategies; emergency department management of AMI patients.

4. A universal 911 system is required to expedite identification and treatment.

GROUP II: PRESENT AND FUTURE PRE-HOSPITAL MANAGEMENT

1. All physicians and nurses should know about their local EMS system and how to access it. The NHLBI should support the development of educational programs to promote an increase in the knowledge of 911 and its purpose.

2. Universal 911 should be available in all communities and enhanced 911, a system that automatically displays the caller's location, should be implemented whenever feasible.

3. Minimum standards and educational programs for dispatchers should be developed.

4. NHLBI should, along with other organizations, support the concept of early defibrillation as one component that is essential for the delivery of health care. Furthermore, all emergency personnel should be trained to operate,

equipped with, and permitted to operate a defibrillator if in their duties they are expected to respond to people in cardiac arrest.

5. Each community needs to coordinate its EMS system response to all suspected cardiac emergencies. The NHLBI and other organizations need to fund further ECG/EMS evaluation research including structure, process, and outcome research.

GROUP III: PRESENT AND FUTURE HOSPITAL MANAGEMENT

1. No more than 60 minutes should elapse between the first direct patient encounter with health care personnel and initiation of definitive treatment for the uncomplicated patient.

2. Facilitate efforts to make the correct diagnosis and proper disposition at one extreme for the patient with noncardiac chest pain and at the other for the patient with transmural myocardial infarction.

3. Hasten therapy, including use of reperfusion therapy.

4. Provide a framework for sensitivity for patient's emotional and privacy needs in the emergency department.

5. Facilitate cost-effective approaches, evaluation, and outcome analyses.

These recommendations will influence programs developed both by the NHLBI and by other organizations involved. These recommendations will also be used as guidelines for legislation, both at the federal level and the state level. Cardiac care will change as these programs are enacted. We must evaluate our systems to meet this new challenge.

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