

THE AVAILABILITY OF AMBULANCE SERVICES IN MADISON COUNTY, NY

Peter Klepeis
Department of Geography
Colgate University
Hamilton, NY 13346

ABSTRACT: Rapid emergency medical intervention has been demonstrated to be an important factor in decreasing mortality rates due to medical emergencies. Rural regions are less densely populated than urban centers, and so ambulance services must cover greater distances. With low call volumes, rural regions often rely on volunteer ambulance personnel who must be paged when an emergency response is necessary. These and other factors lead to longer and more geographically uneven runtimes for rural regions than urban ones. In an upstate New York county, containing both rural and urban sectors, the patterning of ambulance service accessibility is analyzed with a focus on the spatial variation of runtimes. How much of the county has substandard access to ambulance services? The effect of such factors as ambulance bases and their service areas, hospital location, population density, and the level of care provided by ambulance personnel on the geography of emergency medical treatment is analyzed. Findings expose shortcomings of dependence upon volunteer ambulance corps for providing modern, efficient emergency medical care.

INTRODUCTION

The role of emergency medical services (EMS) has grown significantly in the past few decades. It has been well established that rapid emergency medical intervention is an important factor in decreasing mortality rates (Eisenberg et al, 1979). For example, in cases of cardiac arrest, a patient must receive cardio-pulmonary resuscitation (CPR) within 4-6 minutes or permanent brain damage may occur. Mayer (1979) measured the survival rate of cardiac arrest victims and found that relations between survival and response times are minimal in a system where the average response time is less than three minutes. Such fast response times are not realistic in rural areas. It is imperative that ambulances respond quickly, have properly trained personnel, and that transport to advanced medical care is expeditious. Ambulances in rural areas often take longer to respond to a scene than those in urban regions. Madison County, located in the geographic center of New York State, has both rural and urban populations. This study will analyze the availability of ambulance services in Madison County to see if there are regions that are relatively isolated from emergency medical care. Analysis will allow for a general understanding of the characteristics of ambulance services in a rural setting to be exposed.

Rural regions do not have as easy access to health care services as urban populations. It has been established that the number of physicians per capita tends to be higher in metropolitan areas than in rural ones (Rundall 1982). Likewise, the number of rural hospitals is fewer due to a lower population distribution and so a lesser demand for hospital services than an urban environment. While urban ambulance services have a high enough call volume to merit full time, salaried Emergency Medical Technicians (EMT), rural regions often rely on volunteers to man their ambulances. The

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volunteers are on call, not waiting at the ambulance base, and so response times to the scene are extended the time it takes the personnel to get to the base. Populations of rural regions are by definition more spread out and so patients can be difficult to get to. Preventative medicine is not as available in rural areas and the Medicare costs are relatively higher in such regions as in urban ones (Meade et al 1988; Rundall, Nycz, Schmelzer 1992). All this may lead to poorer health care availability for rural patients than for urban ones.

Seventy percent of traumatic fatalities occur in rural areas, even though seventy percent of the country's population lives in urban areas (Rutledge et al. 1992; Baker et al. 1987). This can be due to extended response time of the ambulance to the scene, the administration of improper emergency medical care, and the transportation of the patient to a facility that is incapable of treating the injuries. In EMS there is something called the "golden hour." It refers to the time between the moment of serious injury to the patient and when that patient goes into the operating room. If more than one hour passes between these two events then patient survival rates fall off dramatically. Thus, not only is it important to have fast response times to the scene but also fast response times from the scene to the hospital. Also, it is important that the patient go to a facility that has the staff and equipment to handle serious traumatic injury. Most small rural hospitals are not so equipped and transferal to a designated trauma center is delayed. Volunteers often do not have the experience nor training to evaluate and treat severe injuries.

Most of the research on accessibility of health care and ambulance services has focused on urban areas rather than rural ones (Mayer 1979, Gesler 1988, Morrill 1970). When access is defined as the availability of financial and health system resources in an area then rural areas have been found to have inaccessible health services. Such regions are deficient in professional medical personnel, physical health care facilities, and the ability to afford the financial cost of illness (Aday 1974, 209; Rundall 1982; Meade et al 1988). Aday (1974) shows the inter-relationship between the many complex variables that are a part of the health care availability issue. Among these variables are both perceived and actual need of the population, convenience of the health care facilities, distribution of resources, type of health services offered, and many more. Meade (1988) shows that when analyzing health care delivery systems, four aspects of the issue must be concentrated on: health problems, health personnel and facilities, location of services, and the use of those services. It is essentially the location of services variable that this study will address. Aday (1974) says that geographic accessibility is a function of the time and distance traversed in order to get to care. This certainly applies to ambulance services and their ability to service the population in their region.

Below are the fundamental questions that will be addressed in this study:

1. What are the locations of ambulance bases servicing the region of study?
2. What is the nature and quality of care provided by the ambulance services?
3. What are the runtimes for urban and rural regions of Madison County and how do they compare?
4. What are the implications of these runtimes for access to ambulance care by the residents of Madison County?
5. What are important issues to be analyzed when evaluating ambulance services in rural area?

METHODOLOGY

The primary mechanism for analyzing the availability of ambulance services in Madison County will be runtimes. Runtimes contain four categories: response time, scene time, destination time,

and total runtime. Response time is the time between when an emergency call goes into an ambulance service and the time when the ambulance arrives on scene. Scene time is the amount of time an ambulance spends on the scene. Destination time is the time from when the ambulance leaves the scene with the patient until the time it arrives at its destination, most likely a hospital. Total runtime refers to the time from when an emergency call goes into an ambulance service and the time the ambulance drops the patient off at the hospital.

Emergency medical personnel are not allowed to release any personal or private information regarding their patients. This includes anything that will identify a particular person with a certain location or type of medical emergency. The information necessary for the completion of the project was runtimes, emergency call locations. This allowed for a distribution of emergency calls to be mapped and an analysis of response times to be performed. Runtime and call location information were accessed from ambulance run forms kept by each respective ambulance service.

Data collection proved to be difficult. Ambulance personnel were reluctant to release their data. The fire coordinator of Madison County was convinced of the validity of the study and that no personal patient information was to be gathered. Yet, the Fire Coordinator wanted to oversee actual data collection and thus time restraints did not allow for a large sample size to be gathered. It is probable that a concern over the exposure of faults or weaknesses in the system was partially responsible for the difficulty in accessing data. In addition, ambulance personnel were not readily available, data was at times difficult to locate, the process of data collection itself a slow one, and runtimes were often missing from run sheets. Data from the month of February, 1992, was gathered. February is in the middle of the winter, road conditions are at their worst, and the response times should be at their slowest. While gathering the response time data, ambulance personnel and the fire coordinator were interviewed about the nature and quality of emergency medical services in Madison County. The availability of advanced life support (ALS) personnel, the way the EMS system works, and areas that called for improvement were ascertained. In this way, the study allowed for a rudimentary understanding of the system to be formulated and basic problems to be laid out.

In order to map the spatial distribution of responses, county map files were needed, including the road networks, town, and city boundaries. The locations of the emergency scenes were mapped with the aid of personnel who knew the street names and colloquial terms for certain locations (such as high schools, bars and other businesses, etc.). The fire coordinator supplied digitized mapfiles of the county. These were imported into a Mapinfo geographical information system (GIS). The emergency scenes and ambulance bases were added in pointfiles. Thus, a dot map of the distribution of response scenes was created.

To assess availability of ambulance services, mean times will be compared and an ANOVA test employed. Analyses will be broken down by ambulance service area and population density. The destination time will show if the hospitals are available to the ambulances and the scene time will evaluate if there is delay in transport of the patient. The total runtime will show the level of overall availability of the population not only to ambulance services but to the ambulance services rapidly transporting them to the hospital, doctors, and definitive emergency medical care.

DATA ANALYSIS

As Figure 1 one shows, population density tends to be greater in the northern towns of Oneida, Sullivan, and Lenox. Conversely, the southern towns tend to be less densely populated. If we then compare this to the distribution of ambulance bases and emergency calls shown in Figure 2 (there are thirteen private, fire-based, and volunteer-based ambulance services in the county), we see

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that the most rural areas do not have a good sample of emergency calls represented. We can see that there are rural regions that do not have an ambulance base nearby. Further study, and a greater sample size, should help to understand whether there are populations in these areas that are relatively isolated. Any such analysis would have to take into consideration topography, road density, and other factors influencing ambulance response time.

Table 1 shows the mean runtimes and the sample size for each ambulance provider. We see that the more urban areas served by Oneida, Cazenovia Area Volunteer Ambulance Corps (CAVAC), and Greater Lenox ambulance services have shorter response times when compared with the more rural regions served by Southern Madison Ambulance Corps (SOMAC) and Morrisville. However, Eastern-Bridgeport's ambulance response time is the longest and the service is located in one of the more densely populated regions of the county. This shows that the hypothesis that the rural regions will be the more isolated in terms of response time does not hold true in all cases.

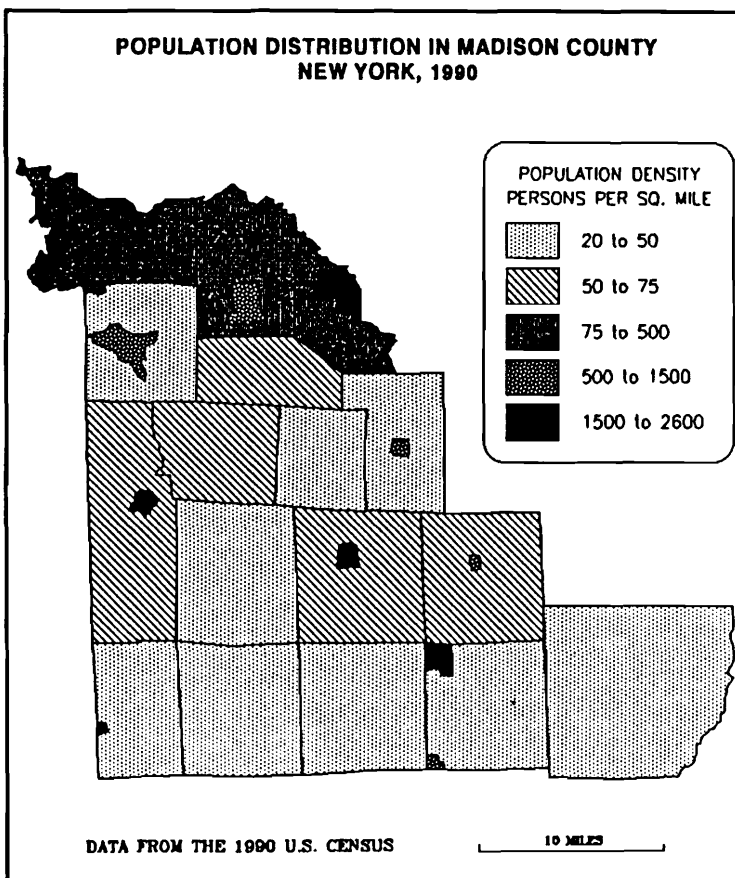


Figure 1: Population Distribution in Madison County

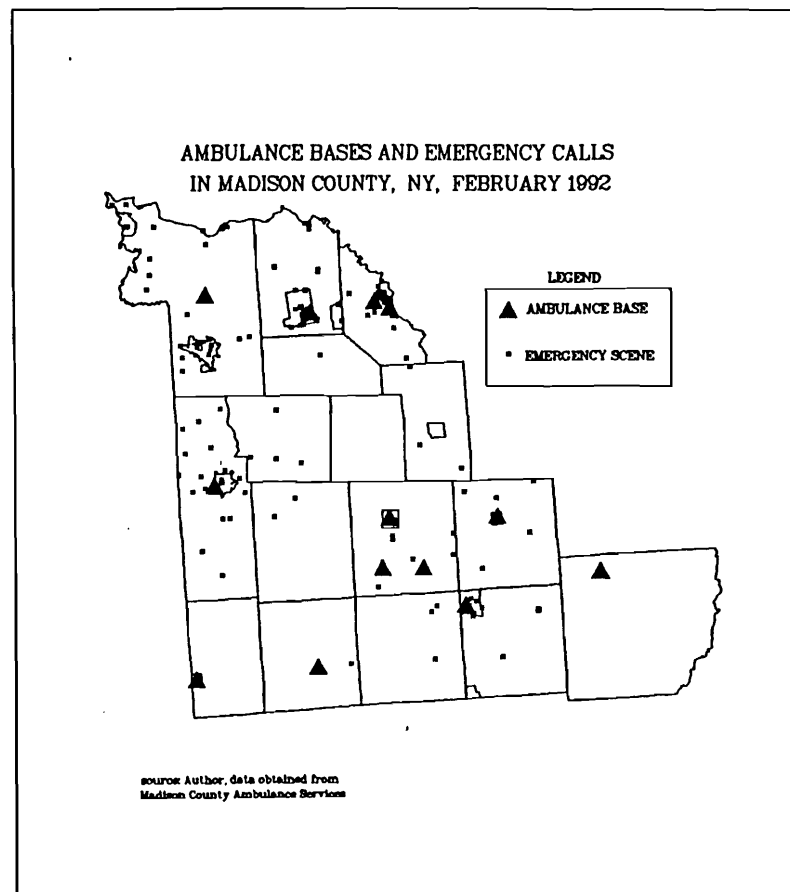


Figure 2: Ambulance Base and Emergency Call Distribution in Madison County

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Table 1. Sample Size and Mean Response, Scene, and Destination Times

Provider	Resptime		Scentime		Desttime	
	Mean (min)	Count	Mean (min)	Count	Mean (min)	Count
OneidaV	4.1	10	17.3	10	5.2	10
OneidaF	6.7	27	14.7	27	11.3	27
CAVAC	7.7	39	20.7	31	34.1	39
GLAS	8.0	38	19.2	37	18.9	35
EastC	8.2	17	21.2	12	33.1	11
Eaton	9.3	3	24.7	3	12.3	3
Madison	11.0	5	18.0	5	10.0	5
EastN	11.3	3	11.5	4	30.5	2
Morris	11.6	19	28.1	15	16.1	14
SOMAC	11.9	17	11.4	17	13.1	17
EastB	13.2	11	23.0	8	30.6	7
Total	8.7	189	18.8	169	20.1	162

There are only two hospitals in Madison County. They are located in the city of Oneida and in the town of Hamilton. Thus, it makes sense that Oneida and SOMAC have short destination times. By comparing destination times we see that CAVAC and Eastern- Bridgeport, in Sullivan, have the longest destination times. So, not only does Sullivan have an ambulance with a long mean response time but it also is in a region that does not easily access hospitals. Yet, there are reasons for having unusually long destination times. By law, patients are allowed to request what hospital to which they wish to be transported. So, the patient may end up being transported to a hospital that is not the closest to the emergency scene and result in a longer destination time than necessary. Also, EMTs are in connect with a medical control a doctor who directs the course of treatment by radio. Medical control may tell the EMTs to transport a patient to a facility that is more capable of treating the condition but that isn't the nearest facility. Thus, in order to come to a true understanding of the effect destination time has on the quality of care a patient receives a case by case study would have to be performed.

Finally, Table 1 shows the relationship between mean scene times for ambulance services in Madison County. Morrisville ambulance squad has a mean scene time of over 25 minutes while SOMAC has a mean of just over 10 minutes. There is no empirical evidence that supports a particular guideline for how long an ambulance crew should spend on scene. Certainly, there are many reasons for having a long scene time. For example, a motor vehicle accident may require significant time to extricate the patient from the car or the emergency may be so minor that the patient need not be rushed away to the hospital immediately. However, in a rural area, with extended destination times, EMTs should delay their response to the hospital as little as possible. Properly trained EMTs should be able to load the patient into the ambulance rapidly and stabilize them en route.

At this point, a correlation analysis was performed to ascertain if those ambulance services that tended to have longer runtimes in one category also had longer times in another. The results showed that those regions that tend to have long response times also tend to have long destination times. When we look at the mean total runtime in Figure 3, we see that Eastern- Bridgeport has the greatest

total mean runtime. It had the longest response time as well as the longest destination time. Total mean runtime gives a good idea of the availability of the hospital via the ambulance for the patients of a particular region. In some areas of the county, EMS's "Golden Hour" would come and go without the patient reaching the hospital.

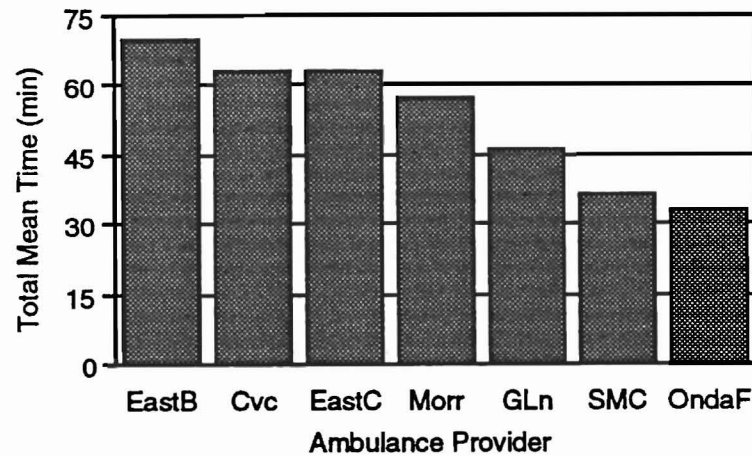


Figure 3: Mean Total Ambulance Runtime for Madison County, NY, February 1992

The runtimes of GLAS, Oneida-Fiore, and CAVAC underwent an ANOVA test. Only in the cases of destination time and total runtime were there statistically significant differences between the ambulance providers. Figure 4 shows the differences in mean total runtime ($F\text{-Value}=21.615$, $P\text{-Value}<.0001$). The bars around each mean represent the 95% confidence interval. We see that Oneida has the most densely populated region and the lowest mean. The next most densely populated region is Greater Lenox and there is some overlap but we can say with great confidence that there are significant differences in mean total runtime between the two regions. The most rural area, served by CAVAC, has significantly higher mean total runtimes than the other, more densely populated areas of the county. The test for mean destination showed a similar pattern with there being significant differences in destination time between the rural and urban regions ($F\text{-Value}=32.267$, $P\text{-Value}<.0001$). Rural regions are less likely to have access to ambulance services with regard to total run and destination times.

DISCUSSION

In order to compare urban and rural regions of the county, population data needed to be the smallest enumeration possible. Ideally, tiger files would be accessed in order that block level data could be mapped. This would show the correlation between runtimes in specific regions of the county and the equivalent population density for that same region. If the response time data were representative of the entire county then a contour map could be created with the isolines representing response time. In this way, pockets that had relatively long response times would be exposed. These regions would then be analyzed, with regard to topography or road density, for example, to discover

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why the regions were so isolated. Yet, until a sample that is large enough is gathered this cannot be possible.

The town of Sullivan is in an urban area and yet has the worst total runtime of any other region in the county. It is a private ambulance corps, staffed by paramedics, who are able to give medicines, IV therapy, and in general provide a higher standard of care than basic EMTs. Private ambulance personnel tend to be better trained and have more experience than volunteers. So, despite the fact that the runtimes for Eastern are slow, they may provide a standard of care that is higher than a region in which runtimes are faster but that doesn't have advanced life support personnel readily available. Another example where runtimes may not demonstrate the quality of emergency medical care can be seen in SOMAC's service area. Although SOMAC has low runtimes because a hospital is nearby, the hospital is small and does not have the experienced emergency room staff nor technical equipment for dealing with serious medical problems that some of the other hospitals have. So, with respect to quality emergency medical care, the people in the service area of SOMAC may not have EMS services as available when compared to Oneida or another region of the county.

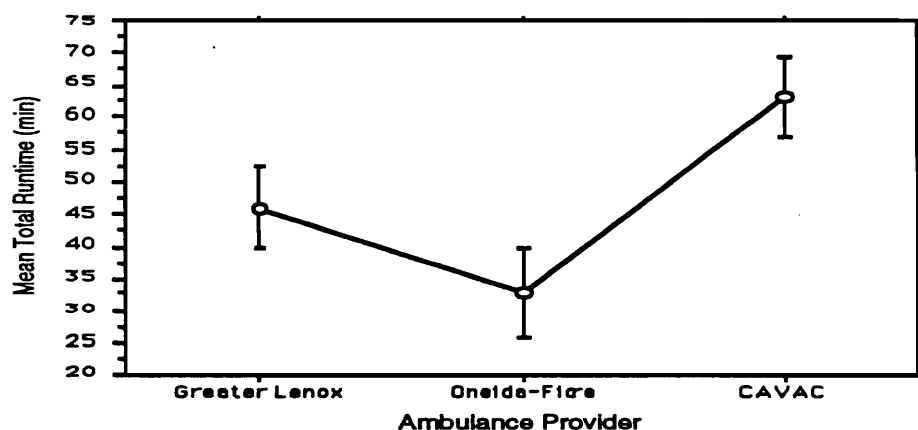


Figure 4. ANOVA Results for Total Runtime in Madison County, NY, February 1992.

The ambulance personnel of Madison County were concerned with other availability issues. A factor that effects the time it takes for a patient to receive emergency medical care is the responsibility of the patient. If they are having a heart attack have they waited too long while experiencing symptoms? Do they know when to call an ambulance and when not to? A question that may be enlightening is whether rural ambulance services are abused as much as urban ones are? Another concern is that volunteers in rural areas are required to make great sacrifice in order to provide a good standard of care. Issues of lost productivity at work, hours devoted to training, and time away from family are issues that must addressed. The population expects the highest care possible, such as is offered by paramedics, but in rural areas it is difficult to maintain paramedic certification. Questions pertaining to what level of care should be expected from volunteers, with limited funding and manpower, should be explored.

Madison County is now in the process of installing a 911 system. This will allow the dispatcher to learn the exact location of the call immediately as she takes the call, as well as other

pertinent information such as whether the patient has a past medical history. This can only serve to expedite the time it takes for an ambulance to find the scene. Communications systems are being evaluated as well which should address concerns of EMTs over radio problems.

CONCLUSION

By analyzing the runtimes of ambulance services in Madison County, NY, regions were exposed that have relatively less access to emergency medical care. The hypothesis that rural regions tend to have longer runtimes and so are more isolated was found to be true in most cases. Yet, Eastern-Bridgeport ambulance services an urban area compared to SOMAC, CAVAC, and Morrisville. It has the longest total runtime of any of the regions. One of the most important implications of the study is that if a service such as Eastern that has good equipment, well trained people, ambulances staffed 24 hours a day, and still has poor ambulance availability, rural populations may have no choice but to accept the risk that goes along with living in an isolated region. Also, many of the ambulance services are staffed by volunteers that have limitations with regard to experience and training. Hospitals are not readily available to ambulances and their patients in many areas. By cutting down on scene time, ambulance services may be able to improve on their overall runtime. The study allows for a general idea of the availability of ambulance services in Madison County but a larger sample size is needed before isolated regions can be located with certainty.

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