Searching for Cost-Effectiveness in Emergency Medical Services

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ost local governments in North Carolina provide ambulance and emergency medical services (EMS) using various arrangements. Growth in population, changes for first responders in the post–9/11 era, and changes in Medicare's fee schedules for reimbursement for ambulance services have created pressures to manage the costs and the efficiency of ambulance services and EMS in many counties.

This article reports on the efforts of three local governments and a countysupported regional medical center in Lee County, Alabama, to find an intergovernmental solution to provision of these vital services. In Lee County, pressures to reduce the appropriations for ambulance services and EMS led an ad hoc committee consisting of representatives of the four entities in the county to propose funding of a comprehensive study using industrial engineering techniques. The results may be of value to North Carolina officials as they struggle with similar cost situations.

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Comparison of Lee County and North Carolina Counties

Lee County and its towns have important similarities with one out of five North Carolina counties. First, Lee County's overall population of about 123,000 is comparable to that of twenty North Carolina counties with populations from 90,000 to 170,000.

Second, the challenge of serving one or two large cities and a more sparsely populated area of county residents is similar to that faced by seventeen North Carolina counties. Lee County's population density is 189 persons per square mile. North Carolina counties ranging from Pasquotank and Wayne in the east, to Caldwell, Cleveland, and Iredell in the center and the west, have densities of 150–225 persons per square mile.

Finally, the overall land area of Lee County is more than 600 square miles, much like that in fourteen North Carolina counties whose land area is 550–700 square miles. (For the particular counties that are comparable on these various measures, see the sidebar on this page.)

Background

Like many growing southern counties, Lee County has faced escalating costs for the government services demanded by its increasingly urban population. As a result, local officials are interested in finding ways to provide services more efficiently. Lee County consists of several incorporated areas and a vast expanse of small rural developments and farmland. Two contiguous major cities—Auburn, a jurisdiction of about 47,000 people and the home of Auburn University, and Opelika, a jurisdiction of about 24,000 people and the county seat—make up the urban population. Opelika has stagnated for several decades, but Auburn has doubled its population in the past twenty-five years. The county and the two cities have worked together for two decades to provide some services, such as an airport, jails, visitors' services, and ambulance services. The cooperation has resulted in cost savings and greater effectiveness.

EMS, however, has been difficult to provide efficiently and effectively to Lee County's diverse population. Auburn– Opelika, the urban center, represents only a small percentage of the land area of the county and is relatively easy to serve, but the county's sparsely populated rural area is spread in all four directions from the urban area. Smiths Station, a recently incorporated city of a few thousand, is on the eastern border of the county but still depends heavily on the county government to provide urban services.

Before 1980, several private ambulance services served the county, primarily the two cities. The mayors of the two cities and Lee County's probate judge (who by virtue of that position served as chair of the county commission) considered the services inadequate because of their lack of professionalism, training, and dependability. In the early 1980s, Auburn's mayor led an effort to improve ambulance services by contracting with the East Alabama Medical Center, the only hospital in the county, located in Opelika. Through months of skillful negotiation and support building, the mayor developed a consensus to upgrade ambulance services.

As a result, the cities and the county developed a joint ambulance service to serve the entire county from one central location—the hospital. However, the two cities did not want to give up separate EMS divisions in their fire departments. Instead, they agreed to cover emergency calls in designated rural sections of the county at no cost to the county government.

In the late 1980s, Auburn city leaders approached hospital administrators and Opelika officials with a plan to consolidate the EMS operations of both cities with the hospital's ambulance service. Auburn policy analysts had determined that in more than 90 percent of the calls

Comparison of Lee County, Alabama, with North Carolina Counties

Lee County, Alabama Population: 123,254 Population of municipalities: Auburn, 46,923; Opelika, 23,498 Area: 609 square miles Population density: 189.1 persons/square mile

North Carolina Counties Population of

90.000-170.000 Alamance Cabarrus Catawba Cleveland Craven Davidson Harnett Henderson Iredell Johnston New Hanover Onslow Orange Pitt Randolph Robeson Rockingham Rowan Union Wayne

Population Density of 150-225 Persons/ Square Mile Burke Caldwell Cleveland Iredell Johnston Lee Lincoln Nash Onslow Pasquotank Pitt Randolph Rockingham Union Vance Wayne Wilson

Land Area of 550–700 Square Miles

Bertie Buncombe Chatham Davidson Guilford Harnett Haywood Hyde Iredell Moore Pitt Rockingham Union Wayne

Source: U.S. Census Bureau, State & County QuickFacts, available at http://quickfacts. census.gov (last visited June 28, 2006).



in which an ambulance was needed, the emergency response team was not needed. However, both responded to every call. In addition, the fire chief generally sent a fire truck, and the police dispatched a patrol car. The result was four emergency vehicles arriving at the home of a heart attack victim when only an ambulance was needed. Auburn city leaders questioned the practice of sending fire trucks to every emergency scene.

The fire chief in Opelika convinced the mayor and other city leaders that the consolidated service proposed by Auburn city leaders would lead to a lessening of service in his city. Although the chief's argument was not based on analysis, the elected officials were not willing to override him.

As a result, Auburn proceeded alone to contract with the hospital for a con-

solidated EMS system that included both ambulance services and emergency response. Auburn's ten employees (all paramedics) were given the option of joining the

new EMS organization at the hospital or remaining as firefighters with the fire department. Most of the paramedics accepted employment with the hospital. A few opted to remain with Auburn as firefighters. Auburn's immediate savings in personnel costs were about \$350,000 per year.

Further, Auburn provided space in one of its fire stations for the hospital's EMS crew so that an ambulance could be stationed in the city for the first time. This action eliminated a five-mile com-

In more than 90 percent of 911 calls, an ambulance and three other emergency vehicles were sent when only an ambulance was needed. mute for the ambulance from the hospital to downtown Auburn and lessened response time by 5–7 minutes on most calls.

By the late 1990s, the hospital's manage-

ment of the combined EMS–ambulance service was judged to be a success, with significant savings accruing to Auburn. Opelika continued to provide duplicate service, even though its budget was strained.

In 2002, Medicare established a new fee schedule for reimbursement for ambulance services. They now were to be paid on the basis of the type of call, with a separate charge for mileage.¹ Also, the payments required by Auburn and Opelika to subsidize the county ambu-

Table 1. Emergency Service Demand and Unit Allocation, by Site

	Percenta	ige	Percentage		
Site	of Calls	of Units			
Opelika		41	40		
Auburn		38	40		
Smiths Station		21	20		
Total		100	100		

lance service had increased by 60 percent in ten years and were projected to rise 20 percent over the next five years.²

As a result, Auburn officials suggested a comprehensive study of the EMS– ambulance service to see if it could be made more efficient. At the annual meeting of the ad hoc oversight committee, Opelika and Lee County representatives readily supported the Auburn officials' suggestion, as did the hospital

Figure 1. Demand, in Two-Hour Intervals, for Emergency and Nonemergency Calls Combined



Source: From Jerry A. Davis et al., *Evaluating Emergency Medical Services: Controlling the Rising Cost of Saving Lives*, 26 JOURNAL OF HEALTH AND HUMAN SERVICES ADMINISTRATION 485 (2004). Reprinted by permission.

Figure 2. Probability of Simultaneous Deployment for Emergency and Nonemergency Calls Combined



Source: From Jerry A. Davis et al., *Evaluating Emergency Medical Services: Controlling the Rising Cost of Saving Lives*, 26 JOURNAL OF HEALTH AND HUMAN SERVICES ADMINISTRATION 485 (2004). Reprinted by permission.

Note: The five reserve units are included, for a total of ten.

Table 2. Time Study Results

	EMTs	Supervisors	Billing Office	Dispatchers	
Productive work	21%	67%	88%	22%	
Additional work	7	8	4	3	
Voluntary idle [time]	70	25	8	74	
Involuntary idle [time]	2	0	0	0	

Source: From Jerry A. Davis et al., *Evaluating Emergency Medical Services: Controlling the Rising Cost of Saving Lives*, 26 JOURNAL OF HEALTH AND HUMAN SERVICES ADMINISTRATION 485 (2004). Reprinted by permission.

administrators. Each group agreed to pay one-fourth of the cost of the study.

In response to a request for proposals, the Industrial and Systems Engineering Department at Auburn University submitted a proposal to conduct the study. A research professor and two graduate students would be the principal investigators. In the previous year, the same group had conducted an in-depth analysis of the Auburn Police Department that had been helpful to the city manager and the city council in responding to the police chief's demands for extra staff.³ After discussing all the proposals, the decision-making group decided to contract with the university.

The Efficiency Study

The study commissioned by the local governments was coordinated by the ad hoc oversight committee, which included the mayor, the city manager, and the public safety director of Auburn; the mayor and the fire chief of Opelika; the probate judge of Lee County; and hospital administrators. Working with the committee, the Auburn University researchers defined the study's key objectives as follows:

- To observe and document the current EMS delivery method
- To develop key indicators of system performance
- To evaluate and interpret the key indicators
- To identify and quantify expenses and revenue associated with the ambulance service
- To identify areas of possible improvement and to quantify associated cost savings
- To discuss alternative methods of providing the ambulance services and EMS⁴

The ad hoc committee and the researchers agreed on a research methodology that would center on proven industrial engineering techniques, such as historical data analysis and elemental time studies. Historical data analysis is used to document and quantify current demand patterns. Elemental time studies are used to study repetitious job duties, breaking them down in order to define



key elements and recommend cost-saving changes. The merging of historical data and observational data (elemental time studies) offers a basis for an accurate description of a work environment and for quantifiable, valid, and realistic recommendations.

Historical Data Analysis

To begin the data analysis, the researchers first had to identify and choose potential data sources. In EMS, important data are collected in run logs, patient care reports (PCRs), and insurance documents, among others. For this study the researchers decided that the PCRs would be the primary data source. The PCRs contain data on time of dispatch, time of arrival on scene, time of departure from scene, time of arrival at destination, and severity type (emergency versus nonemergency).⁵

From the PCRs the researchers calculated and analyzed the following metrics:

• Dispatch time—the time elapsed from call receipt to dispatch

- Service time—the total time from dispatch until return to service
- Time spent on scene—the difference between the arrival time and the departure time
- Call volume and severity type by site
- Time of call per twenty-four-hour day
- Number of units simultaneously deployed

These performance metrics allowed the researchers to analyze service efficiency, the efficiency of the allocation of human resources and equipment, and scheduling (peak-demand) efficiency. Findings for service efficiency were a mean emergency response time of 8.6 minutes and a mean service time of 34.0 minutes. Although the response time was slightly higher than Ammons's findings on response time for cities with populations greater than 100,000, the ad hoc committee deemed both metrics acceptable.⁶ The results of the analysis of the efficiency of allocations indicated about a 40-40-20 split of human resources and equipment among Opelika, Auburn, and Smiths Station (see Table 1).⁷ The similarity between site demand and equipment dispersion suggested that the equipment was efficiently allocated.

The peak-demand analysis captured, in two-hour intervals, the number and the percentage of emergency and nonemergency calls received, by time of day (see Figure 1). In military time, peak demand was between 1000 hours (10 A.M.) and 2000 hours (8 P.M.). This finding resulted in the researchers recommending reduction of coverage at Stations 1 and 2 by one unit during the night shift (midnight to 6 A.M.). By doing so, the system could realize a savings per station of \$82,600, resulting in a total savings of more than \$160,000 per year.

The researchers conducted similar demand analyses for days of the week and months of the year. For emergency calls, the results indicated that Friday and Saturday experienced the highest demand, with the other days receiving relatively equal demand. For nonemergency calls, Friday again experienced the highest demand, and Sunday experienced the lowest demand. As for months of the year, September and October were the months of highest demand for emergency and nonemergency calls combined.⁸ (Each fall, more than 90,000 students return to Auburn University, and even more people attend the Auburn University football games.)

Bureaucrats and politicians are prone to overestimation or neglect of cues from the environment because of human beings' inability to process and decode such cues efficiently.⁹ The result is inefficient decisions. In EMS one of



the strongest arguments for increased staffing levels centers on the possibility of simultaneous deployment. This argument puts too much weight on the likelihood of a crisis. Thus an important analysis for local EMS and ambulance service providers is the probability of simultaneous deployment.

The Auburn University researchers' analysis of the relative and cumulative probabilities of multiple-unit deployment in Lee County showed about a 50 percent probability that no unit would be deployed at any one time, about an 80 percent probability that one unit or less would be deployed, and a more than 90 percent probability that two units or less would be deployed (see Figure 2). This finding indicates that simultaneous deployment, although possible, should not dominate arguments for continuing inefficient staffing arrangements. In the post-9/11 environment, such a metric also should be used by other emergency services to ensure an informed discussion of emergency response staffing.

Elemental Time Studies

The ad hoc committee insisted on moving beyond historical data analysis. The region had been changing quickly, so the committee believed that observational data were needed to make informed decisions. As a result, the researchers conducted "shift time studies," in which the researchers spent entire work shifts with the employees, studying major job functions. They performed about 405 hours of observation, 325 of which were dedicated to observing the work of emergency medical technicians (EMTs). The time studies focused on identifying and analyzing the job functions of EMTs, dispatchers, supervisors, and billing personnel. The job tasks were identified as productive work, additional work, voluntary idle time, and involuntary idle time. "Productive work" was defined as work directly related to EMS (communications, administration, travel, patient care, and dispatch); "additional work," as station and unit cleanup and miscellaneous tasks; "voluntary idle time," as time for sleeping, personal hygiene, and socializing; and "involuntary idle time," as idle time over which the individual being studied had no control.10

EMS staff and equipment were situated throughout Lee County: 2 units at Station I (Opelika), 2 at Station II (Auburn), and 1 at Station III (Smiths Station). A unit was normally staffed by two paramedics (EMT–Ps), the highest EMT level and highest pay grade. The 2002 workforce consisted of 3 dispatchers, 5 supervisors, 2 billing personnel, and 51 EMTs, 84 percent of whom were EMT–Ps, 12 percent EMT–II's (intermediate), and 4 percent EMT–I's (basic).¹¹

The time studies identified several areas of opportunity in staffing allocation and job functions. For example, units were normally staffed by EMT–Ps. This practice created units with maximum costs. Thus, one recommendation was to move to a tiered response system relying on units with mixed EMT levels and pay grades—say, an EMT–P, an EMT–I, and a driver, instead of two EMT–Ps and a driver. By diversifying the units, the system could save more than \$100,000, depending on the cost to hire new EMT–I's or EMT–II's.

Savings also could come from combining the job functions of various office personnel. The productive time worked by the billing office, the supervisors, and the dispatchers suggested an interesting opportunity (see Table 2). The billing office used 88 percent of its time in productive work. However, the dispatchers spent 77 percent of their time in unproductive work (additional work plus voluntary idle time), and the supervisors were involved in voluntary idle tasks 25 percent of the time. Improved efficiency could result from the supervisors and the dispatchers using their voluntary idle time to perform billing tasks, eliminating or reducing the need for the billing office. Also, merging the ambulance dispatch service with existing local government dispatch operations in Auburn and Opelika might result in savings.¹²

The Intergovernmental Cooperation

Between 1980 and 2000, Auburn and the East Alabama Medical Center experienced a successful intergovernmental relationship in providing consolidated EMS and ambulance service. Auburn realized an immediate savings of about \$350,000 per year, and the hospital received additional revenue with just a small increment in workload (because only about 10 percent of ambulance calls required rescue equipment).

However, Opelika was reluctant to enter the cooperative, resulting in duplicate services and budget inefficiency. Opelika's hesitance was predicated on overestimation of worst-case occurrences, in particular on the judgment that a combined operation would result in reduced service to Opelika.

In light of this, in 2002 the ad hoc committee acknowledged the continuing need for the several entities to work together in order to provide a more efficient ambulance service. Although most of the findings of the study supported the current personnel structure and station location, the committee requested that the hospital administrators implement several recommendations to forestall future increases in the annual operating budget supplement paid by the local governments. Specifically, the committee asked that the number of personnel be reduced during the early morning hours, when call volume was at its lowest.

However, the ad hoc committee was reluctant to implement recommendations that required true cooperation. For example, the study identified potential savings from consolidation of the hospital's ambulance dispatch services with Auburn's and Opelika's existing dispatch services. For various reasons related to trust and turf, the committee did not call for this consolidation. As a result, the potential savings were not realized.

Through their analysis of the Lee County ambulance services, the researchers identified the following enablers and constraints to intergovernmental cooperation:

Enablers

- The willingness of all governments to cooperate for a workable solution that would benefit all parties
- The use of independent and reputable consultants to obtain objective recommendations on service efficiency
- The researchers' regular reporting to the ad hoc committee on their progress

Constraints

- Perceptions of a power imbalance among the parties (representatives of one government sensing that representatives of another government were having too much influence on the outcome of the study), in an otherwise competitive environment among the governments
- A fear that one party would benefit at the expense of the others
- Personal dislike or distrust based on previous efforts to cooperate

Conclusion

An interesting element of the study was its use of industrial engineering techniques such as elemental time studies and historical data analysis to evaluate the county's EMS structure. These kinds of techniques are rarely used in the public sector, despite constant pressure on local government officials to be more efficient.¹³ Objective data-collection measures (time studies) provide an accurate representation of the system, and they serve as a solid foundation from which to continue generating recommendations for improvement.

An unusual outcome of the study was the hospital administrators' conclusion that the EMS-ambulance service did not generate enough money or good will for the hospital. As a result, they encouraged the ad hoc committee to consider alternative means of providing the service. Since 2003 the committee has met occasionally and studied various options, including privatization. As of this writing, serious discussions are under way about alternative arrangements beyond privatization, including creation of an EMS special district directly supported by the taxpayers. This development suggests a willingness to consider a long-term arrangement that would institutionalize intergovernmental cooperation in order to provide efficient ambulance services. Moreover, it illustrates awareness that competition among multiple service providers, public or private, might not be efficient and that an EMS district (a service monopoly) might produce the most cost-effective structure.

Intergovernmental cooperation in a Lee County EMS will likely result in a more rational and cost-effective approach to the performance of this vital service. In a more stable political environment, the study might have resulted in immediate implementation and savings. However, in a situation involving three local governments, a hospital, and rural interests, developing a long-term solution is more difficult. Regardless of future steps, the detailed study of the EMS operations provides a solid basis for decision making.

Notes

1. Section 4531(b)(2) of the Balanced Budget Act of 1997 added Section 1834(1) to the Social Security Act. It mandated a national fee schedule for ambulance services performed under Medicare Part B. The fee schedule went into effect on April 1, 2002. *See* Medicare Program; Fee Schedule for Payment of Ambulance Services and Revisions to Physician Certification Requirements for Coverage of Nonemergency Ambulance Services, 67 Fed. Reg. 9100 (2002) (to be codified at 42 CFR pts. 410, 414).

2. Jerry A. Davis et al., *Evaluating Emergency Medical Services:* Controlling the *Rising Cost of Saving Lives*, 26 JOURNAL OF HEALTH AND HUMAN SERVICES ADMINISTRA-TION 485 (2004); Jerry A. Davis, LEE COUNTY EMS EFFICIENCY STUDY, PARTS I & II. TECHNICAL REPORT (Auburn, Ala.: Auburn Univ. College of Eng'g, 2002), available at City of Auburn Public Library, 749 East Thach Ave., Auburn, AL 36830 (Reference 352.9 LEE).

3. Douglas J. Watson et al., Use of Industrial Engineering in Measuring Police Manpower: A Small City Case Study, 26 PUBLIC PERFORMANCE & MANAGEMENT REVIEW 132 (2002).

4. Davis et al., *Evaluating Emergency Medical Services*.

5. Id.

6. DAVID N. AMMONS, MUNICIPAL BENCHMARKS (2d ed., Thousand Oaks, Cal.: Sage Publications, 2001).

7. Davis et al., *Evaluating Emergency Medical Services*.

9. See BRYAN D. JONES, POLITICS AND THE ARCHITECTURE OF CHOICE: BOUNDED RATIONALITY AND GOVERNANCE (Chicago: Univ. of Chicago Press, 2001).

10. Davis et al., *Evaluating Emergency Medical Services*.

12. Id.

13. Watson et al., *Use of Industrial Engineering*.

^{8.} Id.

^{11.} *Id*.