Emergency Medical Services in Maine: Rural Vs Urban Systems

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Abstract

Emergency Medical Services (EMS) in rural and super rural regions in the United States often suffer from human resource and financial difficulties. Times and distances traveled are longer for rural EMS responders, and the closure of Critical Access Hospitals in rural areas lengthens these. Super rural and rural EMS systems are more dependent on volunteers, which come with their own recruitment and retention problems. Rural EMS systems have greater funding difficulties, as they tend not to get tax subsidies. Lastly, rural areas tend to have low EMS call volumes, reducing revenues from insurance and Medicare/Medicaid, which in any case tend not to cover costs sufficiently. The author used a system dynamics model to test three policies: (1) increased payments on a stepped basis, (2) consistent yearly increases, and (3) consolidation of super rural EMS systems, to reduce travel costs. Increasing payments sporadically was not effective, as costs rose constantly and not in synch with this policy's stepwise approach. Consistent yearly increases were more effective, but cost increases reduced its effectiveness, implying the need for indexed payment increases. Lastly, consolidation was an effective policy (although not as effective as indexed payment increases), but comes with bureaucratic and operational difficulties.

Introduction

The history of Emergency Medical Services (EMS) in the United States is one of rags to riches back to rags—at least in some, mostly rural, areas. Prior to 1965, EMS systems were almost non-existent; most "responders" to accidents, injuries or sudden illness were hearses from funeral homes. The Highway Safety Act of 1966 began the expansion of EMS, which enjoyed significant acceleration with the EMS Systems Act of 1973 and the generous funding that came with it (Institute of Medicine, 2007). However, in the 1980s the Federal system of funding changed from EMS-dedicated to "block grants" to states:

> This change shifted responsibility for EMS from the federal to the state level. Once states had greater discretion regarding the use of funds, most chose to spend the money in areas of need other than EMS. Thus the immediate impact of the shift to block grants was a sharp decrease in total funding for EMS…. Moreover, states were left to develop their systems in greater isolation. Some increased their involvement in EMS, but others chose to cede more authority to cities and counties. Political, geographic, and fiscal disparities contributed to fragmented and diverse development of EMS systems at the local level. (Institute of Medicine, 2007: 4)

One of the outcomes of this evolution has been the disparity between urban and rural EMS systems. These range from recruitment and retention difficulties (Edwards, 2019; Freeman, Slifkin, and Patterson, 2009; Freeman et al., 2010), higher mortality rates from traumatic injury (Jarman, et al., 2016; Lu and Davidson, 2017), and inadequate response to opioid overdoses (Cao et al., 2019). MacKenzie and Carlini (2008; 2013) and King et al. (2018) provide detailed discussions of the difficulties of rural EMS, summarized as follows:

- Times and distances traveled are longer for rural EMS responders
- The closure of Critical Access Hospitals in rural areas (82 closed between 2010 and 2018) lengthens distances, and times, even further
- Rural EMS systems are more dependent on volunteers
- Volunteer EMS workforces in rural areas come with recruitment and retention problems
- Rural EMS systems have greater funding difficulties, as they tend not to get tax subsidies
- Rural areas tend to have low EMS call volumes, reducing revenues from insurance and Medicare/Medicaid

Of course, both urban and rural EMS systems suffer from some funding issues (Fitch & Associates, 2014), especially a low rate of payment of bills for ambulance transportation (Brouhard, 2019 calculated that individuals, companies, and government agencies pay only 24.4 percent of ambulance bills), and turnover (Friese, 2018 cites a comprehensive survey finding that annual voluntary turnover among EMTs is 21 percent and among paramedics is 18 percent). Another problem common to both urban and rural EMS systems is that companies and agencies pay only for *transportation*; EMS personnel who respond to and treat patients who then refuse transportation receive no reimbursement (Beers, 2017; Brouhard, 2019; Centers for Medicare & Medicaid Services, 2020b, 2020c).

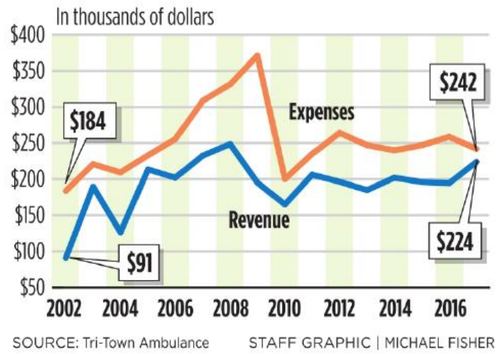

Figure 1 Expenses and revenues of a bankrupt rural EMS provider in Maine

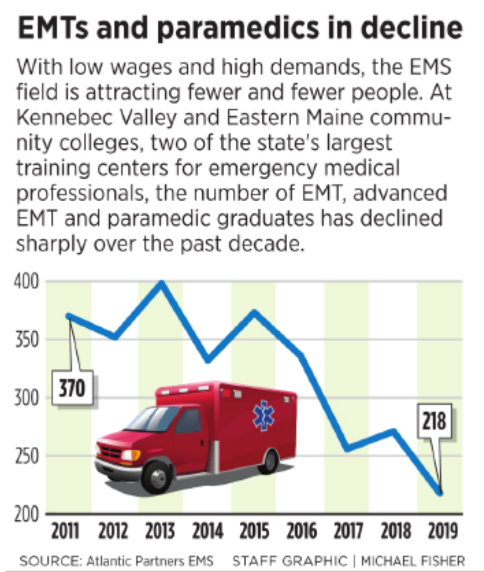

Figure 2 Decline in EMS graduates at Maine's primary training organizations located in rural counties

The author, a resident of Maine in the USA, became aware of these EMS issues from articles in the *Maine Sunday Telegram* ("EMS in Maine on Life Support," Woodard, 2019a) and the *Portland Press Herald* ("Responders Stretched Thin," Woodard, 2019b), which described the dire condition of EMS systems in Maine, especially in rural areas. Woodard (2019a) discussed the staffing and financial problems confronting those EMS systems: highly trained but poorly paid staff; rising costs; Medicare and Medicaid (and most private insurance) payments that are well below those costs; and non-payment for the forty percent of calls that result in costs but no payment. The article included a graphic (Figure 1) showing the expenses and revenues of Tri-Town Ambulance, an EMS service in western Maine that had to end its operations in 2018. Woodard (2019b) focused on the staffing issues in Maine's rural areas, which make up the bulk of the state's land mass. The article mentioned several issues: poor pay; the need for EMS providers to compensate by working multiple EMS jobs; the lack of available EMT graduates (Figure 2) in rural areas; and the lack of a general population from which to draw.

In the wake of the Federal funding changes mentioned earlier, Maine has a somewhat patchwork-like organization of regional districts "directed" by a state EMS bureau. Evaluative committees and consultants (EMSSTAR Group, 2004; Bass, et al., 2016) have at least twice critically evaluated Maine's EMS system. Both times, they highlighted funding issues and lack of strong central authority over the regions. The point is that Maine's EMS issues far predate the recent media attention.

Data from the state of Maine Department of Public Safety's Bureau of Emergency Medical Services (2013; 2014; 2015; 2018), which it breaks down by county, show that the rural/urban divide across EMS systems is as stark in Maine as it is in any other state with large rural areas. Table 1 shows the comparison between Maine's most urban county, Cumberland, and its most rural county, Piscataquis. The urban county has almost double the number of EMS personnel per emergency response and almost fifty times more such personnel per area, showing that Maine is clearly a good example of the conditions mentioned in the literature reviewed earlier. Figures 3 and 4 show that the number of EMTs and Paramedics did indeed decline in Maine between 2013 and 2018 (Figure 3) and in both urban and rural Maine counties (Figure 4). However, it is interesting to note that the percentage decline for both types of counties was the same at 6.5 percent.

	Cumberland	**Piscataquis**
Emergency responses	55,101	5,258
EMS providers	1,123	69
EMS providers per response	0.020	0.013
Area (square miles)	1,217	4,377
EMS providers per square mile	0.92	0.02

Table 1 Comparison of Cumberland (most urban) and Piscataquis (most rural) counties in Maine.

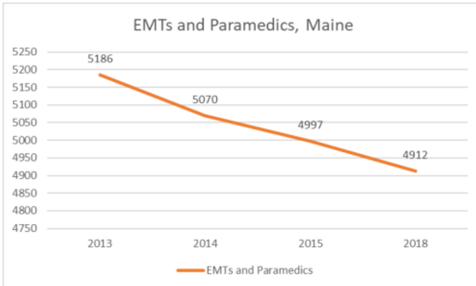

Figure 3 EMTs and Paramedics in Maine, 2013-2018
Source: Maine Bureau of Emergency Medical Services annual reports.

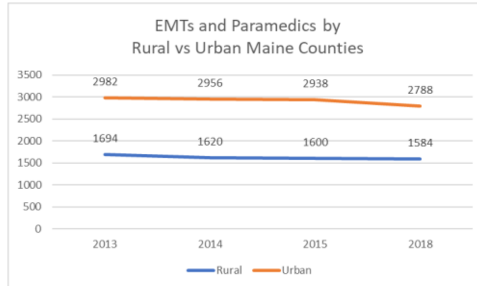

Figure 4 EMTs and Paramedics by Rural vs Urban Maine Counties, 2013-2018
Source: Maine Bureau of Emergency Medical Services annual reports.

Dynamic Hypothesis

Verbal description of problem

The review of literature and data above lead to a clear articulation of the problem of EMS systems in rural areas. Costs are high yet the opportunity to generate revenue to cover those costs is low. Payment for services is poor, even to the point of being non-existent in some cases. Distances that ambulances cover are greater than in urban areas, yet compensating payments are poor. Populations from which to draw trained personnel are low; exacerbating this issue is that the cost and time involved in training are high. Lastly, pay for EMS personnel is poor, in many cases approximating minimum wage, making the jobs unattractive relative to other medical or even non-medical jobs. Indeed, many rural EMS systems provide zero pay, as volunteers entirely staff them.

Causal Loop Diagram

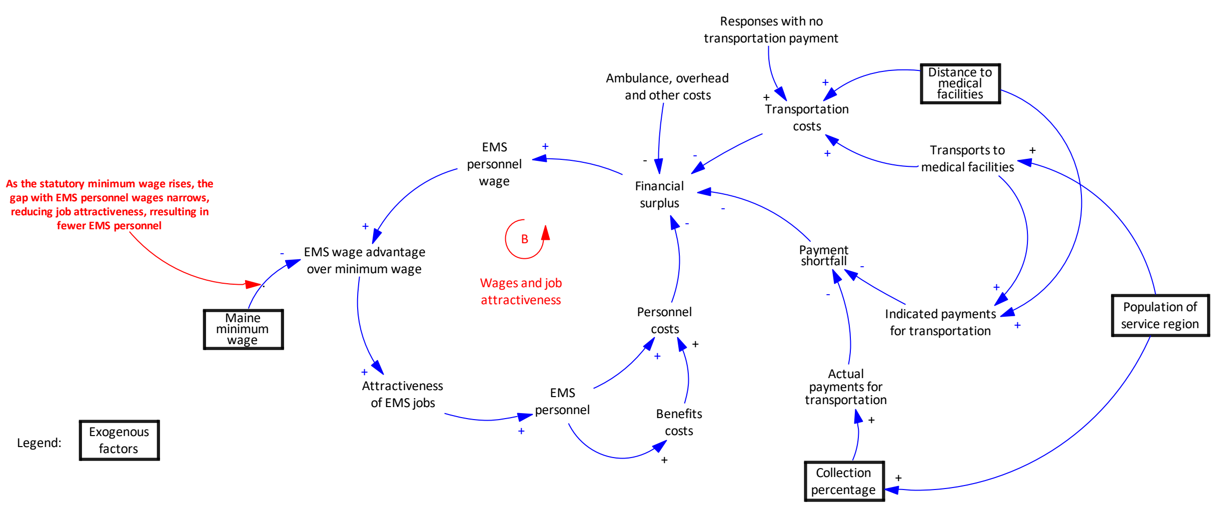

Figure 5 Causal Loop Diagram of Dynamic Hypothesis

Figure 5 shows the causal loop diagram of the dynamic hypothesis. The items in bold boxes are exogenous factors. The Maine minimum wage depends entirely on legislation, and it has risen rather quickly in recent years. For EMTs paid slightly above the minimum wage (this is the case in some rural areas), the closing of the gap between minimum wage and EMT wages reduces the attractiveness of the job. Woodard (2019b) pointed out that if an EMT could work in a convenience store for the same wage, without the attending risks of life-and-death decisions, she or he might opt for that job. (Of course, in areas where volunteers staff EMS systems, this is less of an issue.) This exogenous factor drives the balancing loop “Wages and job attractiveness.” The narrowing gap between the minimum wage and EMS personnel’s wages reduces job attractiveness, which explains some of the reduction in the EMS workforce over recent years.

As the balancing loop shows, EMS managers might close this gap by using surplus revenues to raise EMS personnel’s wages. However, three exogenous factors drive the ability to generate a financial surplus. The first two drive higher costs, while the third reduces revenue:

- **The population of the service region**. This is high for urban regions, but low for rural ones. The higher the population of the service region, the higher the number of potentially paid transports to hospitals. Note that the Centers for Medicare & Medicaid Services divides regions into three categories:
    - Urban
    - Rural
    - Super-rural (2020b; 2020c)

  This paper will use these categories in its analysis, using Maine data for parameter settings.
- **The distance to medical facilities.** This is low for urban areas but high (and therefore costly) for rural and, even more so for, super rural areas.
- **Collection percentage.** This varies between rural and urban areas. It is about twenty-five percent for rural areas and somewhat higher (perhaps as much as thirty-three percent) for urban areas. This is below one hundred percent in both types of regions because many EMS patients lack insurance or insurance providers (private or government) use bureaucratic loopholes to deny payment. According to Brouhard (2019), many patients simply ignore ambulance bills.

One can see how these factors might favor urban regions over rural ones. Populations are higher and distances to medical facilities are shorter. There is even some evidence that the collection percentage is higher in urban than in rural regions. A consultant’s report on the Fire Department, which houses EMS systems, of the City of Portland (Maine’s largest city) stated that EMS revenues from patient billing exceeded expenses by approximately $600,000 (Public Safety Solutions, Inc., 2013: E-16). Based on the research cited earlier, this could only be true if the city collected more than the average twenty-five percent of bills.

Model

Stock and Flow Structure

The author formulated a system dynamics model to capture the relationships depicted in the causal loop diagram. The model has three sectors:

1. **Emergency personnel**. This sector, shown in Figure 6, contains six stocks, four of which relate to actual providers. Please note that there are, roughly, two levels of EMS personnel: (1) Emergency Medical Technicians (EMTs) and (2) paramedics. Paramedics obtain more advanced training and can perform more sophisticated emergency medical interventions. There are several levels of EMTs, but for simplicity we include only one category of EMTs. Here are the four personnel stocks, highlighted in blue in Figure 6:
    a. **Potential paramedics**: the number of people in a region eligible for the service to hire as paramedics.

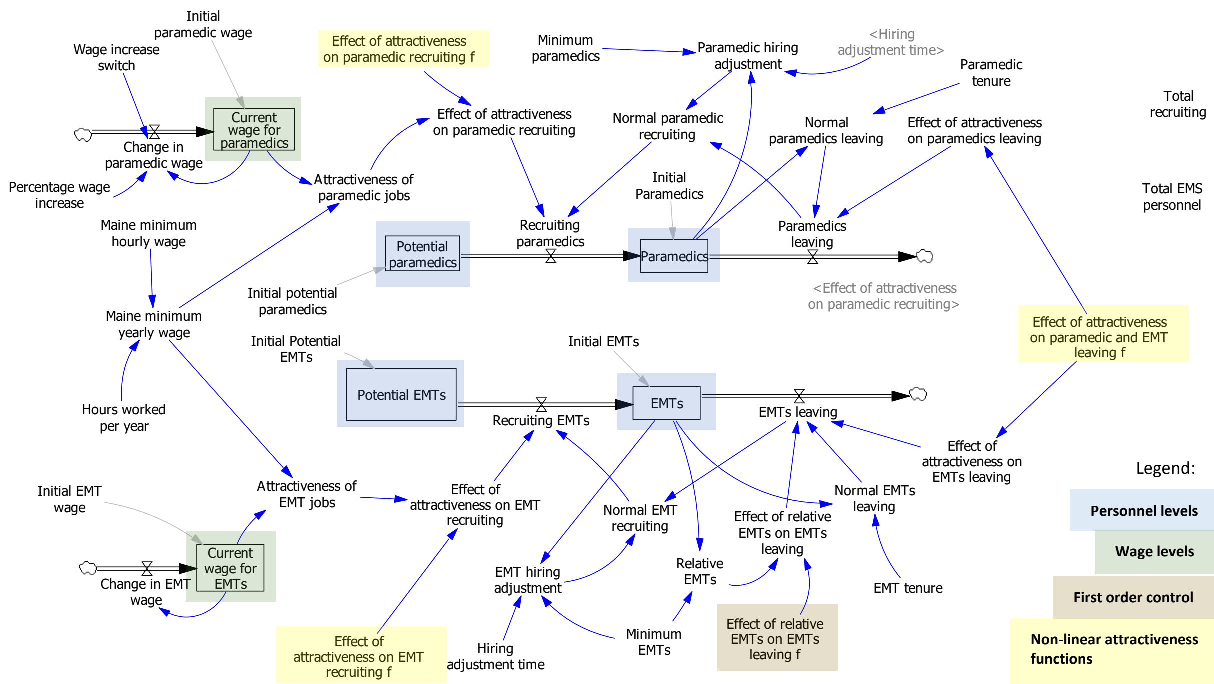

Figure 6 Personnel Sector of EMS Model

i. The initial value is a low number for super-rural, a somewhat higher number for rural, and a high number for urban districts.

b. **Paramedics**: the number of paramedics the service employs, or who volunteer for it.

i. The initial values for these stocks follow the same small, larger, largest pattern.

c. **Potential EMTs**: the number of people in a region eligible for the service to hire as EMTs.

i. Again, the initial value is a low number for super-rural, a somewhat higher number for rural, and a high number for urban districts.

d. **EMTs**: the number of EMTs the service employs, or who volunteer for it.

i. The initial values for these stocks follow the same small, larger, largest pattern.

This sector also has two wage stocks, one each for paramedics and EMTs, highlighted in green in Figure 6. The author formulated these as stocks to allow for a percentage wage increase. The “Wage increase switch” is set at zero when there is break-even or a negative surplus, 1 when there is a surplus. In accordance with the dynamic hypothesis, this allows wages to rise if the EMS service has surplus revenues.

This sector contains one first order control, to prevent the EMT stock from going below zero. It also contains three non-linear functions: two regulate job attractiveness—as wages increase relative to the minimum wage, attractiveness rises—and one regulates personnel outflow—as wages increase relative to the minimum wage, outflow slows.

2. **Transportation.** In the only previous application of system dynamics to EMS that the author could find, Martin and Bacaksizlar (2017) modeled the relationship between call request demand and ambulance capacity *during a typical day*. The present paper differs as it

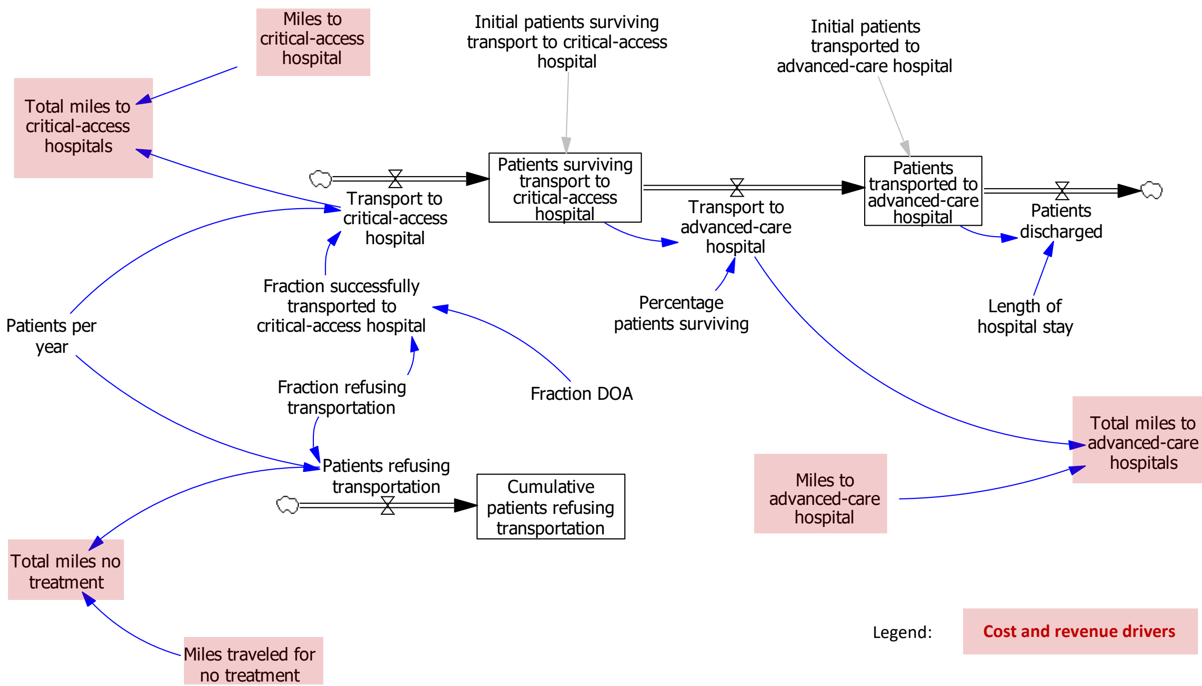

Figure 7 Transportation Sector of EMS Model

examines EMS systems over several years. As Figure 5 showed, ambulances in the present model are simply a cost factor. However, since *transportation* of patients is what generates revenue (Centers for Medicare and Medicaid Services, 2020b, 2020c), the model has a transportation section, shown in Figure 7. Transportation generates costs (mostly mileage-based "wear and tear" on the ambulances) along with revenue (most insurers, especially Medicare and Medicaid, pay only for transportation, not treatment). Therefore, Figure 7 highlights the revenue and cost drivers in red.

3. **Finance.** Lerner et al. (2007) detail a comprehensive framework for determining the costs and revenues of an EMS system (see Table 2). Of the Lerner et al. (2007) framework shown in Table 2, the model consolidates a few elements and does not include others:
   - The model consolidates Physical Plant, Communications, Administrative Overhead and Information Systems into Overhead costs.
   - It does not include Medical Oversight and Bystander Response costs, as the author was not able to obtain data on these, and they are relatively minor anyway.

Figure 8 shows how the model's financial sector captures much of their framework:

a. ***Revenues*** come from charging for emergency and non-emergency transportation. Medicare/Medicaid pay a per-mile price, called a "Base rate payment" (which is higher for Advanced Life Support [ALS] transport and lower for Basic Life Support [BLS] transport). The miles multiplied by the type of transport yields nominal revenue. However, as mentioned earlier, ambulance providers tend to receive a "Collection fraction" of about 25 percent, so actual revenue is only a fraction of nominal revenue.

Human Resources: All personnel involved in organized EMS response, whether paid or unpaid, including any labor costs associated with the headings below (e.g., fields providers, dispatchers, maintenance, billing, training personal):
- Salaries
- Benefits
- Overtime
- Training (overtime pay, stipend, etc.)

Physical Plant (e.g., any buildings necessary to train, provide, maintain or administer the EMS system)
- Acquisition
- Operation
- Maintenance
- Replacement

Vehicles (ground, air, and water)
- Acquisition
- Operation
- Maintenance
- Replacement

Equipment: medical, personal protective equipment (e.g., turnout gear, hazmat, infectious material protection), etc.
- Durable (e.g., 12-lead EKG machines, uniform)
  - Acquisition
  - Operation
  - Maintenance
  - Replacement
- Consumables (e.g., oxygen, medicine, bandages)
  - Acquisition
  - Replacement (including caused by expiration)

Communications
- Public safety answering point equipment and facility
  - Acquisition
  - Operation
  - Replacement
  - Maintenance
- Dispatch center
  - Software (e.g., Computer Aided Dispatch system, Systems Status Management)
  - Equipment and facility
  - Acquisition
  - Operation
  - Maintenance
  - Replacement
- In-vehicle communication devices
- Portable/wireless devices, including radios, cell telephones
- Online medical control/hospital communications
- EMS communication infrastructure (e.g., trunk system, telephone system, or satellite [but not cell telephone towers etc. because it is a sunk cost])
- Acquisition
  - Replacement
  - Operation
  - Maintenance

Medical Oversight (physician may be employed by EMS agency, in which case accounted for above; otherwise, estimate cost not simply charges; also consider that administrative overhead categories listed below for this activity may be borne by other entities but should accounted for [e.g., malpractice insurance, travel, communication equipment])
- Quality assurance/quality improvement of out-of-hospital emergency care
- Direct (online)
- Indirect (offline)

Administration Overhead
- Quality assurance of system
- Occupational safety (e.g., fit testing, vaccinations)
- Occupational health
- Services
  - Janitorial
  - Laundry
  - Water, sewer, and electric utilities
  - Billing, collections
- Insurance
  - Liability
  - Workers compensation
  - Vehicle
  - Assets/building
- Secretarial
- Legal
- Human resources
- Regulatory compliance
- Office equipment consumable and durable
- Personnel recruitment
- Accreditation (Commission on Accreditation of Air Medical services, etc.)
- Travel
- Accounting and auditing

Training
- Initial (e.g., instructor, location, durable and consumable equipment)
- Continuing (e.g., instructor, location, durable and consumable equipment)

Information systems (including but not limited to medical record systems and billing systems)
- Acquisition
- Operation
- Maintenance
- Replacement

Bystander Response to Medical Emergencies (e.g. community CPR defibrillation or first aid)
- Training (e.g., instructor, location, equipment)
- Equipment
- Retraining

Table 2 EMS system cost framework. Source: Lerner et al., 2007

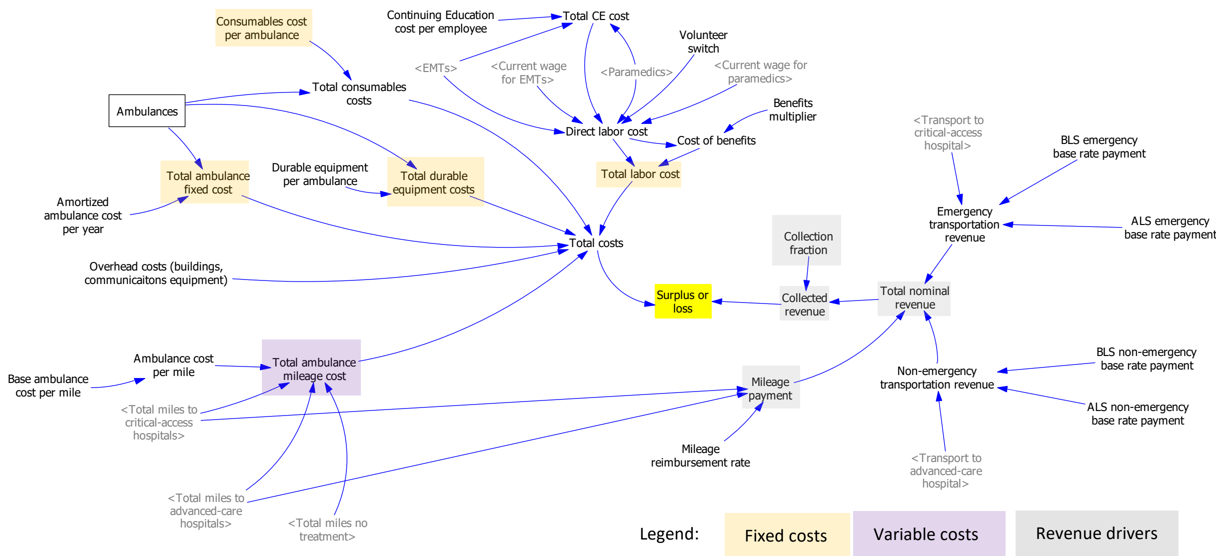

Figure 8 Financial Sector of EMS Model

a. ***Fixed costs*** come from the ambulances, their associated equipment and consumable supplies, and labor (including salaries and training) (Kiger, 2016).
b. ***Variable costs*** come from the per-mile cost of operating the service's ambulances.
c. ***Surplus or loss*** is simply actual revenues minus total costs.

Assumptions and Limitations

The model period is 2013-2022 and contains some assumptions and limitations:

- There is a yearly linear increase of $0.03 in ambulance cost per mile.
- There is a percentage rate of increase in overhead costs of three percent.
- There is a three percent per year wage increase that happens only if the EMS service has a surplus.
- The delay in hiring an EMT or paramedic is 1 year in super-rural and rural areas, and six months in urban areas.
- The number of *potential* EMTs or paramedics rises from super-rural to rural to urban service areas.
- Even though some EMTs might study to become paramedics, the model does not connect these two stocks. EMTs are mobile enough that those who convert to paramedics would not necessarily join the pool within the area in question.
- A significant limitation of this model is that it does not capture any service deficiencies. Even though many super rural and rural districts bemoan the lack of personnel, they claim that service levels do not suffer. Whether that is true, this model, currently, does not capture service quality or "work pressure."
- This is a stylized model allowing the user to set parameters *within the three categories of EMS systems*, according to the exogenous factors characterizing those regions.

Table 3 shows, in greyed comment cells, the parameter setting for these assumptions.

Parameter and units	Super-Rural Base Case	Rural Base Case	Urban Base Case	Source or Comments
Base ambulance cost per mile ($/mile)	1	1	1	Beers (2009)
Base ambulance cost per mile yearly increase ($/mile/year)	0.03	0.03	0.03	Assumed: linear cost increase
Overhead costs percentage increase ($/year)	0.03	0.03	0.03	Assumed: percentage cost increase
EMT tenure (year)	5.5	5.5	5.5	Friese (2018)
Paramedic tenure (year)	4.75	4.75	4.75	Friese (2018)
Percentage wage increase (dimensionless/year)	0.03	0.03	0.03	Assumed: Applies if surplus
Continuing Education cost per employee ($/person/year)	400	400	400	EMT & Fire Training Incorporated 2020a, 2020b
BLS emergency transport initial payment ($/person)	446.14	363.87	360.34	Centers for M/M Services 2020a
BLS non-emergency transport initial payment ($/person)	278.82	227.42	225.21	Centers for M/M Services 2020a
ALS emergency transport initial payment ($/person)	529.75	432.1	427.90	Centers for M/M Services 2020a
ALS non-emergency transport initial payment ($/person)	334.58	272.90	270.25	Centers for M/M Services 2020a
Hiring adjustment time (year)	1	1	0.5	Assumed: Urban hiring faster
Ambulances	1	1	7	Public Safety Solutions (2013)
Initial Potential EMTs (person)	100	200	1000	Assumed based on Maine county populations
Initial Potential paramedics (person)	10	20	200	Assumed based on Maine county populations
Initial EMTs (person)	3	3	21	Public Safety Solutions (2013)
Initial Paramedics (person)	3	3	21	Public Safety Solutions (2013)
Patients per year (person/year)	2500	5000	22000	Maine Department of Public Safety, Bureau of EMS (2013-2018)
Miles to critical-access hospital	50	25	5	Maine Department of Public Safety, Bureau of EMS (2013-2018)
Miles to advanced-care hospital	100	50	5	Maine Department of Public Safety, Bureau of EMS (2013-2018)
Miles traveled for no treatment	20	10	5	Maine Department of Public Safety, Bureau of EMS (2013-2018)
Fraction DOA (dimensionless)	0.04	0.01	0.01	Jarman et al. (2016); Lu & Davidson (2017); Super-Rural DOAs higher
Initial patients surviving transport to critical-access hospital (person)	1840	3700	16220	Beer (2009)
Initial patients transported to advanced-care hospital (person)	150	300	1330	Beer (2009)
Collection fraction (dimensionless)	0.25	0.25	0.30	Brouhard (2019); Urban collection better

Table 3 Parameter Settings for Scenarios (assumptions in greyed cells)

Parameters

Table 3 also shows data-based parameter settings and the sources of the data. These include:

- Base ambulance cost per mile, used to calculate overall ambulance variable cost.
- EMT and Paramedic tenure, used to formulate outflow rates from those stocks
- Continuing Education cost per employee
- Four types of payments prescribed by the Centers for Medicare and Medicaid Services:
    - BLS (Basic Life Support) emergency transport initial payment
    - BLS non-emergency transport initial payment
    - ALS (Advanced Life Support) emergency transport initial payment
    - ALS non-emergency transport initial payment

- Hiring adjustment time, which is a year in non-urban areas and six months in urban areas.
- Ambulances
- Initial EMTs and Initial Paramedics, which vary based on non-urban versus urban.
- Patients per year, which vary greatly among super-rural, rural and urban areas.
- Miles to critical-access or advanced-care hospitals, which also vary greatly among super-rural, rural and urban areas.
- Miles traveled for no treatment. Since payment agencies pay only for transport, these generate variable costs but no revenue, and they vary by area.
- Fraction DOA, which is considerably higher in super-rural areas than in the other two types of area.
- Initial patients surviving transport to critical-access hospital, which varies by area.
- Initial patients transported to advanced-care hospital, which varies by area.
- Collection fraction, which is typically twenty-five percent but is probably closer to thirty percent in urban areas, which tend to have a higher proportion of insured patients.

The author created four scenarios for testing: Super Rural, Super Rural volunteer, Rural, and Urban. Table 3 shows the specific values used for each scenario. These conform to the discussion immediately above.

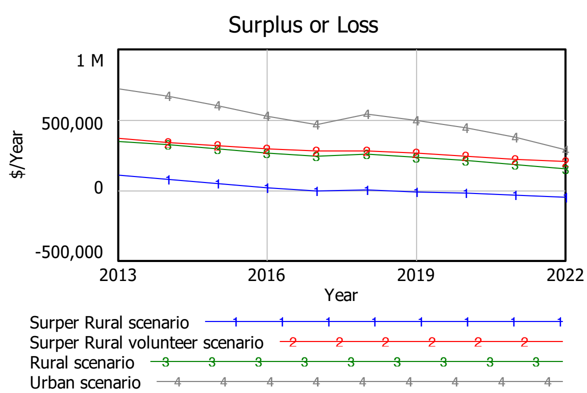

Figure 9 Surplus or Loss, Four Scenarios

Simulation Results

Surplus or Loss

Figure 9 shows the results for financial Surplus or Loss for the four scenarios. They are much as expected:

1. **Super Rural** (blue line 1 in Figure 9)**.** These are the most remote types of areas, which have the most severe financial problems, despite getting larger payments (*if* they get them) from insurers. The reader can see that they start out slightly above break-even and end at a slight deficit by the end of the simulation. This is the pattern noted in most of the literature about remote, super rural areas.
2. **Super Rural volunteer** (red line 2 in Figure 9). This result shows why so many super rural areas end up relying on volunteers. Having no employee wage costs (using the Volunteer switch in the model) results in those services being much more financially viable. Even though they are in financial decline, they remain in surplus for the length of the simulation. Indeed, using volunteers brings these super rural areas close to par with rural areas.
3. **Rural** (green line 3 in Figure 9). Having slightly shorter travel distances allows the rural EMS service in the model to remain above break-even, although the surplus trend is declining toward loss.
4. **Urban** (gray line 4 in Figure 9). With very short travel distances and a higher collection fraction on payments, urban services maintain good surpluses. However, the results show slightly greater volatility for this type of service, possibly because of higher employment numbers.

In all four scenarios, the services are declining toward loss, with a leveling off at around 2018. The leveling comes from that year's modest increase in payment rates by Medicare and Medicaid, but the increases are one-time, while *cost* increases are continuous. That growing gap is what leads to the across-the-board pattern of declining surplus observed in Figure 9.

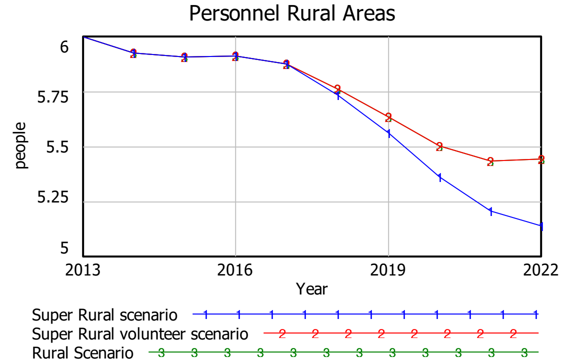

Figure 10 EMS Personnel in Super Rural and Rural Areas
(Note that curves are the same for Super Rural volunteer (red line 2) and Rural (green line 3)

Decline in Personnel Numbers

The literature on EMS personnel describes a declining pattern, worst in super rural areas, slightly better in rural areas, best in urban areas. Figure 10 shows the simulation results for super rural (with and without volunteers) and rural areas. Super rural EMS systems that use volunteers show a declining pattern that is equivalent to rural areas, with a decline and a leveling near the end of the simulation period. Super rural services that rely on paid EMS personnel show a more sharply declining trend, with continued decline at the end.

The employment pattern among urban EMS organizations shows in Figure 11, and it is better than those in rural regions. There is a decline, but it is only slight (from 42 to 40 personnel), and the trend appears poised to rise near the end of the simulation period.

Figure 12 shows the underlying issue behind these patterns—the narrowing gap between the minimum wage and wages in the EMS professions and the effect of that gap on the attractiveness of the jobs. Up through 2017, the minimum wage does not change, while surpluses for all three kinds of EMS systems allow increases in wages (and therefore attractiveness of jobs) for EMTs and paramedics. However, as the minimum wage increases after 2016 (and very substantially after 2017), the gap between it and the typical salary for EMS personnel narrows. This reduces the attractiveness of the EMS jobs, particularly the EMT job (see lines 3 and 4 in Figure 12). This problem is worst for super rural regions, as their anemic (or non-existent) surpluses eliminate wage increases, leading to persistent widening gaps (see lines 1 and 3 in Figure 12).

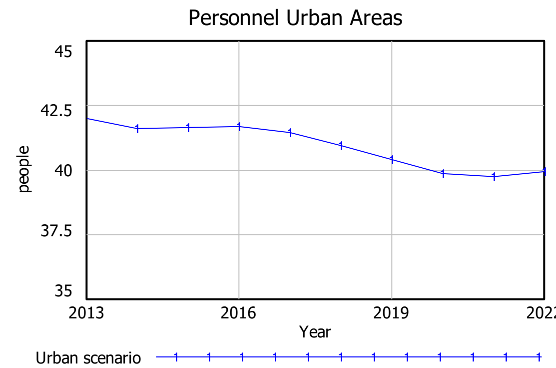

Figure 11 EMS Personnel in Urban Areas

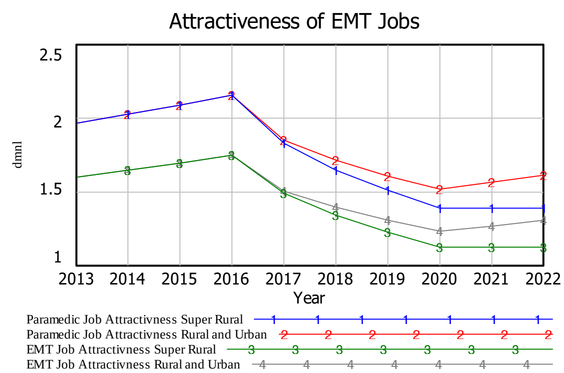

Figure 12 Attractiveness of EMS Jobs

Summary of Results

Figures 9 through 12 demonstrate that the model generates results that mirror well the financial and human resource results that many sources discuss, as noted earlier. The question is how might an

EMS service, particularly those in super rural areas, address these issues. We turn to that now, maintaining a focus on EMS systems in the long-suffering super rural regions.

Testing Potential Policies for Super Rural EMS systems

The only historical policy that seemed to lead to healthy, financially stable EMS systems was the direct federal funding that created the system. Since the conversion to block grants, states have struggled, as related in this paper, to create financially sustainable EMS systems, especially in remote super rural areas. Relatively few policy levers exist to remedy this problem.

Increasing Payments to Super Rural Areas

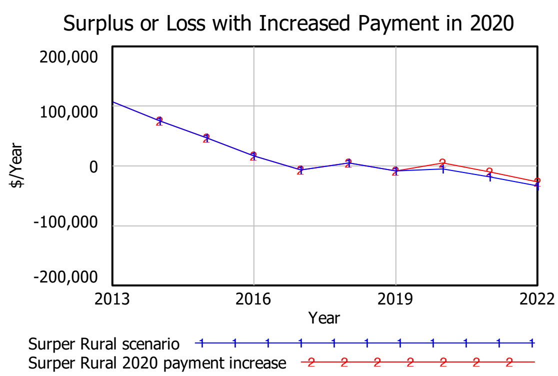

Figure 13 Test of Increased Payment in 2020

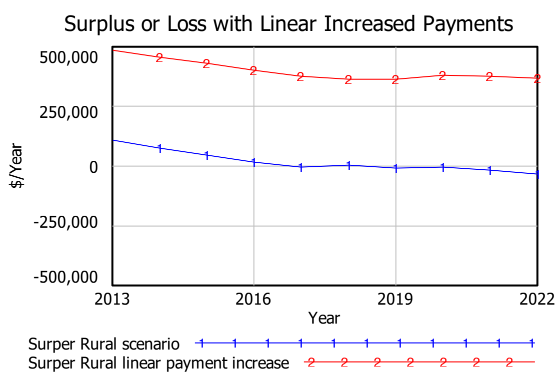

Figure 14 Test of Linear Increased Payment Starting in 2018

As related earlier in this paper, super rural EMS systems have come to rely on insurance payments (both private and governmental) to make ends meet. Accordingly, the Centers for Medicare & Medicaid Services (CMS) periodically increases those payments (which private insurance companies often mimic). The model used in this paper runs from 2013 to 2022 and includes such an increase, which occurred in 2018. Even though there is no discussion among US federal policy makers to have another such increase, the author simulated a repeat increase in 2020 for super rural areas.

Figure 13 shows the expected, but only modestly successful, result of this policy. The essential shape of the super rural Surplus or Loss curve (blue line 1 in Figure 13) changes only minimally in the policy test (red line 2 in Figure 13). The curve shows a small increase in 2020 but a decline that parallels the super rural base case, albeit at a slightly higher level.

This result implies that CMS should increase payments more often. Figure 14 shows the result of a linear increase in each of the four types of payments. This is a better policy (red line 2) than the existing super rural policy (blue line 1), but the result is still decline in financial performance—shallower, but still declining. *This is because costs keep rising, and it implies that, for this type of policy to succeed, CMS would have to index its payment increases to rising costs*. This unlikely policy would obviously be best for any kind of EMS service, but especially super rural ones.

The author examined the effects on EMS personnel and job attractiveness for both the step payment and linearly increasing payments. Figure 15 shows the results. The results for the one-time payment increase (red line 2) was almost identical to the base super rural scenario (green line 3), but the linear payment increase had a significantly better effect on the number of EMS personnel (blue line 1).

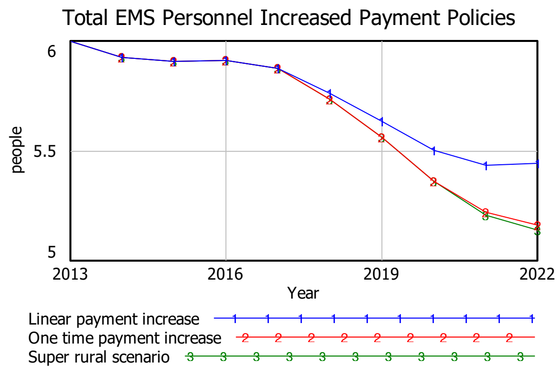

Figure 15 Effects of Payment Policies on EMS Personnel

However, as previously mentioned, this policy relies on unlikely changes from policymakers in the US federal government.

Consolidating Super Rural EMS systems

Some have suggested that EMS systems in super rural areas consolidate and deploy their ambulances to better locations, ones determined not by municipality but by overall regional demand patterns. Were this possible, the result would be akin to creating the rural service model but in super rural areas—i.e., the same number of personnel and ambulances per given region, but (potentially) with shorter distances to hospitals.

Figure 16 shows the result of a simulation where the CMS payments were the same as for super rural areas, and the number of ambulances and personnel were the same, but the distances traveled were shorter—the same as for rural areas. While still showing a long-term decline in financial performance, this is a much better result (red line 2) than the current super rural scenario (blue line 1). As one might expect, the consolidation policy's effect on total EMS personnel is also positive (red line 2 in Figure 17).

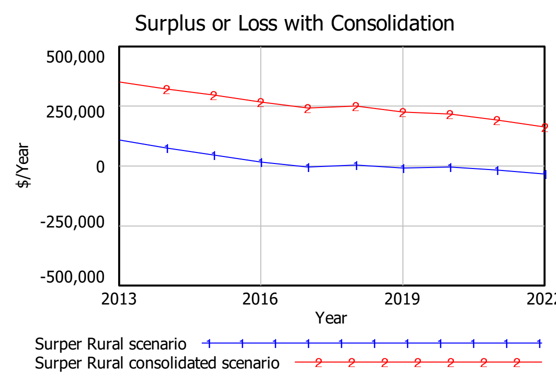

Figure 16 Test of Consolidation Policy on Surplus

As with many proposed policies from system dynamics simulations, implementation of this policy would be difficult. It may be that the CMS would not regard a consolidated super rural EMS service as still being *super* rural, leading it to cut its payments down to rural levels. Furthermore, deploying ambulances in ways that reduce response distances might prove trickier than this policy test assumes.

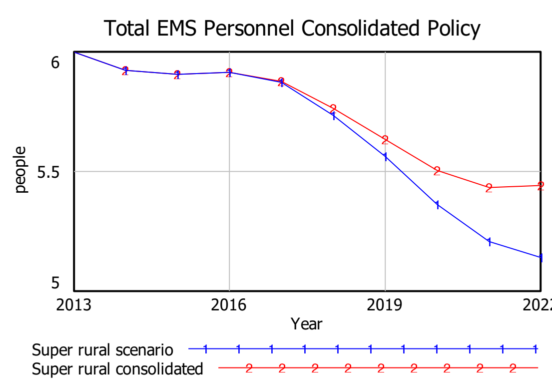

Figure 17 Test of Consolidation Policy on Total EMS Personnel

Other Policy Options

EMS systems in the United States use the Anglo-American model (Al-Shaqsi, 2010), where EMS personnel stabilize patients at the scene and transport them to hospital emergency departments as quickly as possible. In Europe beyond the U.K., EMS systems use the Franco-German model (Al-Shaqsi, 2010); in this model, emergency physicians are part of the response team, and the goal is to administer treatment en route, bypass the hospital emergency department, and directly admit the patient. Norway uses the Franco-German model (Cooke et al. 2001), but as McArthur et al. (2014) discovered that rural areas in that country are nevertheless more expensive than urban ones. Norway uses a different funding model than most U.S. states do, providing central government funding to four Regional Health Authorities. This is like the original U.S. model that disappeared when the federal government replaced it with block grants in the 1980s.

Raising the Collection Fraction

The U.S. state of North Carolina uses the Anglo-American model along with government subsidies in many of its counties, including most of the rural ones (MacKenzie and Carlini, 2008). A news story (Kiel, 2019) related how one rural North Carolina county managed to achieve a 73% collection fraction; the consultant quoted in the article said it was the highest collection fraction he had ever seen. Clearly, a very high-leverage policy would be to raise the collection fraction, but this is likely to prove difficult in most rural areas of the United States. The urban EMS system results from Figure 9 clearly show that this is a high-leverage policy, as increasing the collection fraction from twenty-five percent to thirty-three percent made the urban system go into surplus. A seventy-three percent collection fraction would make for munificent funding levels.

State Subsidies

The EMS system in North Carolina covers any deficits with government subsidies. It may be that using state subsidies is the most realistic option for rural areas in the U.S., providing such funding is available. That North Carolina uses subsidies indicates *that* state's priorities, and it may simply be a matter of priorities for any state. It is interesting to note, thought, that Kiel (2019) reported personnel recruitment and retention issues even for *that* rural North Carolina EMS system.

Summary and Implications

The system dynamics model which is the basis of this paper replicates the patterns of the differing financial and human resource results from Emergency Medical Services in super rural, rural and urban regions. Performance on these measures improves from super rural (poor performance) through rural (mediocre performance) to urban (good performance) EMS systems. The final part of the paper tests various policies that might improve the performance in super rural regions.

These tests show the plight of super rural EMS systems in sharp relief, as the policies most likely to improve their lot are mostly exogenous and out of their direct control. The most potent reform would be to increase payments to EMS systems by indexing them to the rate of medical inflation. The likeliest source of this funding would be the Centers for Medicare and Medicaid Services (CMS), but it is reliant on the Congress of the United States for legislation to authorize increased payments. Not only is this exogenous, it is an unlikely policy. Even less likely is that the various states with super rural EMS systems would appropriate funds for this type of policy, although some states have done so. Maine, the impetus for the present paper, has decentralized funding and is unlikely to follow this policy should the federal government choose not to implement it.

A less potent but still worthwhile policy would be to increase payments in stepwise (as opposed to indexed) fashion on a more frequent schedule. This is akin to a repeated application of band aids to a chronic wound, but it is better than nothing. This is essentially the policy CMS currently follows, but its frequency of increases is quite low. Problems with funding in many states make this policy as unlikely as the policy of indexed payment increases discussed in the previous paragraph.

A policy that states such as Maine *do* have at their disposal is consolidation, whereby super rural EMS systems would de-fragment and cover territory in more coordinated and targeted fashion, deploying ambulances in a way that reduces response distances while maintaining the CMS's highest level of payment. However, both parts of this policy are thorny, as CMS might consider a consolidated

EMS service to have moved from super rural to rural status, which would mean lower payments. It might also be difficult to deploy ambulances in a way that improves distances and costs. In any case, this policy is worth a try, as it has the potential to improved financial viability and stem the outflow of EMS personnel. This model may well provide a more consistent level of quality across the country (which is smaller and more homogenous than the United States), but even the Norwegians have not found a way to make rural EMS more efficient (McArthur et al., 2014).

Two potent but perhaps less realistic policy choices would be to somehow increase an EMS system's collection fraction, or to use state subsidies in rural areas, or both. Either way, it would be wise for EMS systems to spend some of their funding on keeping EMT and paramedic salaries well above the region's prevailing minimum wage.

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