

## CHAPTER 1

# Principles of EMS system design

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### Introduction

Emergency medical services systems consist of the organizations, individuals, facilities, and equipment whose participation is required to ensure timely and medically appropriate responses to requests for prehospital care and medical transportation.

The National EMS Management Association defines the EMS system as the full spectrum of response from recognition of the emergency to initial bystander interventions, access to the health care system, dispatch of an appropriate response, prearrival instructions, direct patient care by trained personnel, and appropriate transport or disposition. A provider participating in any component of this response system is practicing EMS. EMS also includes medical response provided in hazardous environments, rescue situations, disasters and mass casualty incidents, and mass gathering events, as well as interfacility transfer of patients and participation in community health activities [1].

The design of the EMS system addresses how the resources are structured – operationally, financially, legally, and politically. The system design affects virtually every aspect of how requests for services are handled. Changes to the EMS system design can have a profound effect on clinical outcomes, community satisfaction, and cost. Therefore, it is vital for EMS and community leaders, including EMS physicians and medical directors, to have a sound understanding of EMS system design principles and its elements.

The principles and elements of EMS system design vary in some respects between environments, organizational settings, health care system differences, community settings, and cultures. Those differences will be addressed in this chapter.

At the time of this writing in 2013, the health care system in the United States is rapidly changing. As the general health care system changes, EMS system designs will need to adapt accordingly. This makes it all the more important for EMS and community leaders to understand system design principles so they can competently lead and adapt their EMS systems through the tumultuous times

ahead. Agility will become extremely important, as the times ahead are rife with both opportunity and peril.

### System design goals

The design of the EMS system should support the primary goals of providing the best clinical and service quality possible with available resources. Accountabilities embedded in the system design should help align incentives for each provider organization to do its best to help the overall system meet these goals. There are several key areas of the system design that warrant specific attention: clinical quality, service quality, economic efficiency, accountability, improvement, and resilience.

*Clinical quality* addresses the technical performance of clinical processes and the patient outcomes those processes yield. The EMS system design should designate responsibilities, set standards, and create accountabilities for clinical quality.

*Service quality* addresses the experiences and perceptions of patients and other stakeholders. The EMS system design should set realistic and practical standards while establishing accountabilities for service quality just as it does for clinical quality.

*Economic efficiency* can be assessed by how well available resources are utilized to create positive clinical and service quality outcomes. Good system designs provide the best chance of patients receiving quality care within economic reason. This ties into the concept of value – the combined effect of quality and cost [2]. Communities want value from their EMS systems – quality and cost both matter. High quality and reasonable cost are not mutually exclusive choices.

*Accountability* is needed to assure that each provider organization and the major components therein fulfill their respective roles and responsibilities in meeting needs, particularly those of patients and the community. The most important needs are expressed as standards. The best system designs require

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measurement of performance against standards, hold provider organizations accountable for meeting standards, and encourage performance that exceeds standards.

**Improvement** is manifest as a mindset that recognizes that standards often represent *minimum* acceptable levels of performance. It is both worthwhile and possible to exceed those minimums by changing processes in ways that yield better quality at the same or lower cost.

**Resilience** recognizes that the world around us changes in ways that affect the EMS system. Resilient EMS system designs allow for such changes by creating mechanisms that allow adaptations to be made quickly with minimal disruption.

It is sometimes difficult to separate the effect of the system design from the efforts of the individuals who work within it. Some of the key interrelationships are characterized by the following principles.

- Talented and motivated people can produce good results in a bad system design, but not for extended periods of time.
- Incompetence can produce poor results in even the best system design.
- Talented people tend to be attracted to system designs that will potentially nurture and showcase individual talents.
- Talented people have options because they are talented. In general, the most talented managers choose to avoid employment in EMS systems that hinder their abilities.
- Good system design makes excellence possible and superior performance probable, but guarantees neither.
- Bad system design makes excellence impossible and inferior service probable.
- Sound system design cannot guarantee clinically appropriate and economically efficient performance.
- Poor system design can make consistent life-saving performance extremely unlikely, if not impossible.

## Services

Most EMS system designs include the services described below.

### Prevention and public education

These services typically focus on prevention of problems that may lead to an EMS response, such as injury prevention or prevention of heart attacks and strokes. Public education efforts also include instructions on first aid and when to appropriately call for EMS assistance.

### Triage

When someone calls 9-1-1, one of the first services provided is a determination of what the nature of the problem is, its severity, and the types of resources that need to be sent to the scene.

### Medical first response

Sometimes there are medically trained resources closer to the patient than the closest available ambulance. In cases where the nature of the problem may be time-sensitive, good system

designs will attempt to get the closest appropriately trained medical resource to the scene as soon as possible. This is called medical first response. It is typically provided by fire departments, but may also be provided by police agencies or volunteer EMS agencies.

### Ambulance response and transport

Ambulances typically provide the broadest spectrum of EMS services, including medical transportation.

### Prearival instructions

After the incident has been triaged and resources have been dispatched to the scene, emergency medical dispatchers can guide callers on how to begin treatment and help responding crews safely locate and access the scene.

### Assessment and treatment

Emergency medical services crews will evaluate the scene and examine the patient as part of their process to assess the situation and determine what course of action and treatment are called for. They will then initiate treatment as appropriate within the constraints of their protocols.

### Medical transportation

At some point during patient care, determinations will be made regarding the need and destination for medical transport. If patient condition and circumstance allow, those determinations will be made in collaboration with the patient. In scheduled non-emergency situations, medical transportation resources may be requested in advance by appointment.

### Event coverage

Emergency medical services system designs should provide a mechanism for EMS resources to be placed on stand-by for major events. This often requires special logistics and planning so that normal operations are not comprised during the special event.

### Disaster services

Emergency medical services system designs provide mechanisms for threat assessment, planning, activation, and delivery of medical resources and services in response to larger-scale incidents. Responding appropriately to requests for services from other communities in need should also be addressed in the EMS system design.

### Critical care transport

There is often a clinical need to move patients with unstable or complex conditions between medical facilities. Repatriation to an in-network hospital may also prompt such transfers. These patients will often require care outside the normal scope of a paramedic-staffed ALS ambulance. This need is typically met with critical care transport ambulances which have additional equipment or the ability to accommodate additional equipment.

Their staffing is highly variable. Typically, the base level of staffing is with paramedics who have additional training that may qualify them for critical care transport certification. More complex patients may also be accompanied by members of the hospital staff, who may be critical care nurses, respiratory therapists, or physicians.

### **Air medical transport**

Rotor or fixed-wing aircraft may be used as ambulances. Their missions may vary from scene responses to more rural or wilderness incident locations to interfacility transfers. The transfers may be provided at a routine or critical care transport level of care.

### **Hazardous materials response medical support**

Many communities will have specialty fire department teams for response to hazardous materials incidents. Given the wide range of unusual cargo and materials that victims or team members may be exposed to, special training, equipment, and protocols are often established for the paramedics assigned to these teams. EMS medical directors may establish relationships with toxicology specialists to assist in training and medical oversight for these paramedics.

### **Tactical response medical support**

Some law enforcement agencies have tactical response teams. The team members, perpetrators, and victims may be subjected to significant trauma in unusual situations that preclude normal treatment and transport processes. This may necessitate more extensive on-scene assessment and treatment within the confines of a dangerous tactical scene environment. This calls for special training, equipment, and protocols for the paramedics assigned to these teams.

### **Community paramedicine**

Emergency medical services systems are primarily designed to respond to emergencies. A significant portion of EMS requests, however, are for non-emergency situations. This sets up a disparity between what the patients who call 9-1-1 need versus what the EMS system was originally designed to provide. Community paramedicine is a relatively new service that attempts to meet the often underserved need of low-acuity 9-1-1 patients in a more effective and efficient manner than a typical EMS system response provides. Changes in health care system design and payment structures may provide incentives for EMS provider organizations in the near future to leverage their existing infrastructures and resources to provide a broader spectrum of non-emergency out-of-hospital care. EMS provider organizations may be contracted to provide services such as monitoring and support of patients immediately following discharge to reduce length of hospital stays, prevent readmissions, and participate in home care for the chronically ill in ways that traditional home health care services are less suited to provide.

## **Vehicles, equipment, and supplies**

Facets of EMS system design can also address vehicles, equipment, and supplies. These can have a significant effect on clinical and service quality as well as economic efficiency.

Ground ambulance options generally fall into three categories: types I, II and III. These categories were derived from United States ambulance standard KKK-A-1822 [3]. A new US standard has been established called NFPA 1917 [4]. The US ambulance standards tend to have a strong influence on ambulances manufactured in other countries.

Type I ambulances are built on a light- to medium-duty truck chassis. The cab remains and the cargo module is replaced with a patient compartment. The patient compartment typically lasts longer than the cab/chassis module. This permits the patient compartment to periodically be refurbished and then remounted onto a new cab/chassis module. Due to the heavier duty truck construction, type I ambulances can have a longer service life, particularly when the remount strategy is used. Their larger size makes them more difficult to navigate through narrow streets in older, high-density urban areas. Their heavier weight typically makes them less fuel efficient. The balance between longer service life and higher fuel costs must be considered in calculating the total cost per mile and reliability over their entire service life.

Type II ambulances are made on a van chassis. They tend to be much smaller than type I or III ambulances, with more agility and better fuel economy. Their service life tends to be shorter than type I ambulances and does not offer the option of remounting to a new cab/chassis module.

Type III ambulances are also built on van chassis, but have separate cab and patient compartment modules. They are similar in concept to type I ambulances, but on a van chassis rather than a truck chassis.

There is a tremendous variety of non-transport vehicles used for medical first response. When the medical first response agency has a primary mission other than EMS (e.g. fire or law enforcement), the vehicles will often do double duty to meet the need of that agency's primary mission as well as the secondary mission of medical first response. This avoids having to purchase separate vehicles and additional staff to provide medical first response, limiting the cost to accelerated wear and additional fuel. This is why some fire departments will use a fire truck for medical first response. In contrast, some fire departments will choose to use utility-style trucks that have lower operating costs per mile, but with the added cost of another vehicle and additional staffing. EMS leaders should be cognizant of the pros and cons and the complete life-cycle costs for different vehicle options when choosing the type of vehicle to use for fire department medical first response. Law enforcement agencies very consistently use their primary patrol vehicles and regular staff when delivering medical first response.

There are situations where specialty vehicles may be used for transport as well as medical first response. Airports and sports arenas may use specially modified golf carts for transport to a

location where a standard ambulance is positioned. The cart is also used for first response. Agencies in highly congested urban areas may use motorcycles for medical first response. In parks, fairs, and special events, bicycles and Segways may be used. Off-road vehicles may be used where needed: all-terrain vehicles, boats, and snowmobiles. System leaders and medical directors should have an open mind about vehicle specifications in an effort to find the vehicle best suited to the environments they serve.

Equipment and supplies will vary with the clinical service level. Within a particular service level (BLS, ALS), there are many options. For example, agencies have the option of choosing between several brands of automated cardiopulmonary resuscitation (CPR) devices or relying solely on manual CPR. When considering equipment and supply options, the most important factor to consider is the effect on patient outcome. Cost cannot be ignored, however, and can be looked at in more detail from the perspective of cost per use and cost per use over the entire life of the item (if reusable). Size, weight, durability, reliability, and service support also are major factors to consider.

## Delivery settings

The geographic setting of an EMS system can have a significant effect on what constitutes an appropriate system design. What might be entirely appropriate for an EMS system serving a predominantly urban area may not make much sense in a rural or wilderness setting, and viceversa.

### Urban/suburban

Urban/suburban EMS systems are those that serve communities with high-to-moderate population densities, covering larger areas, and are largely self-contained in terms of receiving emergency departments and key emergency health care resources (e.g. cardiac catheterizations labs, trauma centers).

The higher volumes of patients bring higher potential gross revenues. This creates several financially viable options for the type of organization(s) that provide EMS services and the way in which responses are configured. Thus, it is not uncommon for governmental agencies, private companies, and hospitals to all offer EMS services in the same metropolitan area.

When there are multiple EMS provider organizations serving the same metropolitan area, planning and coordination are critical. Incidents ranging from a serious multiple vehicle crash to a passenger train or aircraft wreck will often require multiagency, multijurisdictional responses, particularly if the incident takes place near a jurisdictional line.

Emergency medical services system designs for urban/suburban areas need to consider how the various agencies in multiple jurisdictions will work together in an operationally and medically efficient manner. Best practices in EMS system design for large urban/suburban areas separate the function of system-level medical oversight from that at a provider agency level. System-level medical oversight, often positioned at a county or regional

level, is typically focused on coordination and interoperability issues. It considers issues such as making sure EMS personnel from one jurisdiction have clinical privileges in another when providing mutual aid, and have the same or similar clinical protocols, compatible medical equipment, compatible radio systems, capabilities for data exchange and aggregation, etc. System-level medical oversight might be a county or regional medical director, or it may be provided through a council of the various provider agency medical directors who develop processes to coordinate efforts and come to consensus on multijurisdictional issues. This is something that is also done in some of the better rural and wilderness systems for the same reasons.

One of the biggest drivers of EMS system cost is personnel. Consequently, one of the goals in making the system economically efficient is to maximize productivity, with crews running as many calls as possible during their shifts. There may be limits, however, where crews can become overworked with consequent degradations in quality. In some EMS provider organizations, this is mitigated by reducing the duration of shifts. Governmental EMS agencies in particular will commonly work 24-hour shifts. Without adequate rest during longer shifts, the risk of cognitive errors may increase with consequent loss of clinical quality. There are many ways to address these issues while assuring quality and containing costs, but the system design should recognize this potential and have ways to address it.

Urban and suburban EMS systems will often have emergency and non-emergency ambulance services offered by separate organizations. The emergency ambulance services will tend to be operated by governmental entities providing ALS service. The non-emergency ambulances will tend to be operated as private companies at a BLS or ALS level. This raises two major issues. Is it better to have all ambulances provide ALS service? Is it better to have a single organization provide both emergency and non-emergency ambulance service? These questions are the subject of ongoing debate. Local politics and incumbency of providers will tend to have more influence on this than the theoretical merits from a pure system design perspective. Changes at this level will be difficult to achieve unless there is sufficient political will to do so, which may manifest in response to a severe financial issue, a high-profile case with a bad outcome, or challenges by one provider organization to take over the ambulance duties of the other.

### Single versus multiple ambulance service providers

There are economic and philosophical issues to consider when debating if a community should have one or multiple ambulance services.

From an economic perspective, a single ambulance service provider offers potential cost savings by payers only having to support one infrastructure. More than one provider adds the costs associated with duplications of infrastructure that do not add value. For example, a single ambulance service for a community would have one computer-aided dispatch (CAD) system. A second ambulance service would require its own

CAD. The pricing of ambulance services in that community would need to cover the cost of two CAD systems, without a corresponding increase in benefit. Considering the duplication of all the other elements of infrastructure needed to support an ambulance service, the increases in costs quickly add up.

The economic virtues of competition must also be considered. A single provider has a monopoly, which does not provide natural cost controls or competitive pressure to provide high-quality service in order to preserve or expand market share.

Considering the advantages of single-provider systems and the advantages of competitive pressure to control costs and increase quality, many urban and suburban systems take an approach that can provide a favorable balance. A community can both limit the number of providers and corresponding duplications of infrastructure costs while still providing healthy competitive dynamics. This is achieved by allowing competition *for* the market rather than *within* the market.

While the details vary from state to state, a city or county generally has the ability to designate who its ambulance service provider(s) is/are. This is called allocation of ambulance service market rights and is one of the most powerful tools in EMS system design. When allocating market rights, the city or county can attach a wide range of requirements and performance standards that must be met to retain those market rights. A competitive procurement process may be used to decide which provider will be awarded the market rights. That competitive process can allow both governmental and non-governmental organizations to submit proposals. If true costs are considered and the evaluation process is conducted properly, the community can reap the benefits of getting a provider that has had to make a more compelling value proposition over competing organizations and made commitments to meet requirements and standards on an ongoing basis. After the market rights are awarded, the competitive pressure can be sustained by building in escalating consequences for minor to major failures in meeting requirements and standards, which can result in loss of market rights in the most severe of circumstances. Absent any severe failures, from time to time, the community may choose to reevaluate the market by having another competitive procurement process for allocation of market rights. This will compel the incumbent provider to step up its level of service and commitment in an effort to fend off competitors. Competitors will make their best offers in an effort to capture a new market. Either way, the community benefits.

In communities where this approach is not taken, dislodging a well-established ambulance service provider or providers will require significant political will. Such political will is rare and typically arises in response to severe financial problems, a high-profile case with a bad outcome, or an attempt by one provider to overtake the market rights of another. EMS system leaders should be cognizant of this. If there is interest in having a more formal and deliberate process to allocate ambulance service market rights for the benefits cited above, EMS system leaders should be prepared to introduce these ideas into the political

conversation in the event that the political will to make a significant change surfaces.

A related issue is the separation of emergency and non-emergency ambulance service. In many communities, the governmental agencies will provide an emergency ambulance service while one or more private corporations will provide a non-emergency ambulance service.

This separation tends to be more common with fire department ambulance services. The organizational culture of the fire department tends to focus on provision of emergency services. Non-emergency ambulance service delivery may be shunned by the firefighters. It is not difficult to find private companies more than willing to relieve the local fire department of the "burden" of that portion of the market. This is because the non-emergency ambulance service market can be quite profitable. It has the distinct advantage of being able to determine ability to pay in advance of service delivery. The emergency market can also be profitable, but carries higher financial risk by not having the ability to determine the ability to pay in advance of service delivery. Because many emergency patients do not have the means to pay and all requests for service received through the emergency system are generally honored, the emergency ambulance service is at higher risk for net losses.

When the government-operated emergency ambulance service is operating at a net loss, there may be a business case for a community to retain the non-emergency market rights for its own ambulance service. This could allow profits from non-emergency cases to help cover the losses from the emergency service. This assumes that any organizational culture issues can be adequately addressed and that the managers have the needed skills, experience, and support to operate the ambulance service profitably.

As the overall US health care system changes and the percentage of the general population not covered by insurance presumably decreases, the economics and assumptions just described may significantly change.

### ALS and/or BLS levels of care

One of the virtues of an all-ALS ambulance service is that each ambulance is capable of delivering both ALS and BLS. The problem of undertriage that arises from sending a BLS unit to a case that turns out to need ALS is eliminated. The response time performance of the system is improved by having every unit qualified to "stop the clock" when measuring how long it took to get the correct type of unit to the scene. The incremental cost between operating a BLS and an ALS unit in an organization that has the training, quality management, etc. in place to provide ALS is small. It amounts to the difference in cost of adding ALS equipment and supplies, higher costs for training and continuing education, and the salary differential between an EMT and a paramedic. For these reasons, the all-ALS ambulance service has been favored in many urban and suburban communities.

The counter-arguments, favoring a fleet of BLS ambulances and a smaller cadre of ALS staff, cite the low frequency of the

higher-risk ALS procedures, such as endotracheal intubation. Considering the limited number of opportunities to perform such procedures in an EMS system and dividing by a large number of ALS-level staff in an all-ALS ambulance system results in fewer opportunities to perform those high-risk procedures. Therefore, having a smaller cadre of ALS staff allows them each to have more opportunities to perform those skills to achieve and maintain mastery. This same logic is used to support the idea of specialty care centers for major trauma, cardiac catheterization, etc.

Another facet of the debate questions if ALS offers a significant benefit over BLS. When ALS-level EMS systems began in the 1970s in most urban and suburban communities, paramedics were the only level of field personnel authorized to provide clearly life-saving procedures like defibrillation. Since then, defibrillator technology has made this life-saving procedure available to BLS providers and the lay public. Defibrillation, nebulized bronchodilator drug administration, a selected set of IV fluids and drugs, and some types of airway devices are now in the scope of practice for AEMTs. Having an EMT or AEMT apply 12 ECG electrodes and transmit the data to the receiving ED would not be unreasonable. Given the scope of services that an AEMT can now perform, it questions the justification for having an ALS level of care.

The evidence is insufficient to settle these debates at the time of this writing. It is vital for EMS system leaders to be aware of these controversies, follow the research, and consider these issues carefully when an opportunity presents itself to reconsider the level of service in an EMS system design.

### **Tiered response**

In some EMS systems, more than one agency may be sent to the same incident. This commonly involves sending a non-transport medical first response unit and an ambulance. This is often done under the premise that ambulances tend to be relatively busy and there may be other qualified and available emergency response units closer to the incident location than the nearest available ambulance – hence the term medical “first response” unit.

Some systems will send the ambulance and medical first response unit simultaneously to all calls received via the 9-1-1 system. This is sometimes called a dual or simultaneous response system. The primary advantage is that the worst-case scenario is always covered in terms of getting the closest available unit to the scene as fast as possible. If the medical first response units have a relatively low level of utilization for their primary mission (e.g. fire calls for fire trucks, law enforcement calls for police cars), having them respond at the same time as the ambulance can get someone there sooner. It is acknowledged that most of the medical responses originating from a call to 9-1-1 are not truly time-sensitive emergencies. This points to the major disadvantage of this approach: the medical first response unit will often end up on lower-acuity calls where they may not add significant value by virtue of having responders there a few minutes earlier than

ambulance arrival. If there are a lot of these types of calls, it can add considerable expense to the operating costs of the medical first response agency by needing more units to cover all of the first response calls. It can also significantly decrease availability for the medical first response unit's primary fire or law enforcement mission.

A safe, consistent, and clinically appropriate triage process performed by an appropriately trained and quality-controlled dispatch center offers an option for utilizing medical first response units in a more discriminating manner. Emergency medical dispatchers, using appropriate triage protocols, can identify the types of calls that are more likely to be time-sensitive emergencies that would benefit from arrival of personnel a few minutes sooner (e.g. choking with compromised breathing). It may also be possible to identify cases where having the additional manpower from the first response crew on scene sooner than later is of value (e.g. manpower to properly perform the many tasks at a cardiac arrest scene). Beyond “medical” first response, also consider “fire” and “law enforcement” first response – where fire and/or law enforcement resources are likely to be needed.

### **Hospital destination policies**

In contrast to more rural or wilderness settings, urban/suburban EMS systems will often have several hospitals in or near their service areas. This will necessitate protocols and policies that guide the decision-making process on what hospital the patient will be taken to. Patient requests for specific facilities should be honored, but ideally, the patient should go to the closest hospital that is equipped to provide the type of care needed. Guidance to EMS medical directors and policy makers may be provided by certifications obtained by hospitals to verify their capability to care for specific types of patients (major trauma, burns, ST elevation myocardial infarctions, stroke, etc.).

Emergency departments in urban and suburban areas are prone to overcrowding. This can have a severe negative effect on the EMS system if the overcrowding significantly delays the physical movement of the patient from the ambulance cot to the emergency department bed. Protocols and policies should be put into place to manage this problem. Unaddressed, ambulance services may find that many of their crews are standing by for extended periods of time in the ED hallway waiting for beds to move their patients onto. Collaboration with hospital administrators is needed to help them avoid legal problems and allow the EMS system to use its resources to respond to requests for service.

### **Rural**

Rural systems face many challenges quite different from their urban/suburban counterparts. By definition, they cover areas with lower overall population density but usually have some areas of higher density in small towns and villages.

Funding for rural systems is highly variable. It may be a county-wide system supported by taxes, a subscription-based

program that functions like ambulance insurance, or a volunteer system that works on charitable donations – or most any creative combination thereof that suits the needs and preferences of those who live in the service area.

The smaller tax base in rural communities also makes it more difficult to afford expensive technology. Enhanced 9-1-1 systems that automatically provide the emergency dispatcher with the address associated with the caller's phone number or the real-time location of the calling cell phone may be out of reach. This can lead to further delays in arrival.

Creativity is often exercised in designing a response configuration. Local funding may not support having on-duty staff standing by with the ambulance or medical/rescue first response vehicle. Rural systems will commonly alert staff members by phone or pager that a call has been received. Available crew members can then respond from home or work to the ambulance or rescue vehicle to muster a crew and then proceed in the ambulance or rescue unit to the scene of the incident.

Response time intervals may be dramatically reduced when some staff respond directly to the scene and have appropriate equipment and supplies with them to help initiate care until the ambulance and additional staff arrive. This type of tiered response necessitates policies and procedures to appropriately control when and how that all happens.

Rural systems are often designed with separate BLS and ALS response agencies in mind. The first tier is often a BLS ambulance. If the call requires ALS, the ALS agency often sends a non-transport vehicle staffed by paramedics. The paramedic can either respond to the scene or "intercept" the BLS ambulance along the way to the hospital.

A huge challenge for rural services is handling overlapping calls. A large geographic area may only have one ambulance. When that ambulance has a call that requires transport, the hospital may be quite distant. This can result in a single call lasting for hours. If another call occurs during that time, it would have to be covered by a more distant unit or wait until the ambulance gets back into the area. This places added responsibility on medical first response crews, if utilized, to manage the patient for longer periods of time.

Emergency medical services education for rural staff is more complicated. Initial training may only be offered in distant cities, which can be particularly challenging for volunteer staff to attend. The lower call volume in rural systems creates barriers to developing and maintaining skills, particularly for high-risk, low-frequency procedures like endotracheal intubation. This makes refresher training all the more important. Evolving and increasingly more affordable technologies for online distance education can be particularly important for rural providers.

The combination of long distances for responses and transport, compounded by the problem of even longer time frames in the event of overlapping calls, results in much longer periods of patient contact than in urban/suburban systems. There is more time for patients to get sicker before ambulance arrival and more time to deteriorate before reaching a hospital. This potentially heightens the need for ALS-level care in the rural setting.

The low call volume, lower levels of funding, and other factors make it much more difficult to pay for and properly support paramedic services. This is commonly referred to as the rural paramedic paradox [5].

### **Industrial**

Industrial EMS is typically provided on the site of larger and sometimes more isolated industrial facilities. Most commonly, it is provided at sites where there are atypical hazards requiring specialized methods of rescue or care. Large oil refineries and chemical plants are good examples of settings with these characteristics. It may also include large factory complexes in urban areas.

Industrial EMS services are usually provided as part of an industrial plant's operations or by a support service contractor. How that company, industrial EMS staff, and their system of care integrate with the general EMS system that provides service outside the industrial site is a significant issue. There must be coordination with the agency with responsibility for regulatory and medical oversight in the jurisdiction where the industrial site is located. The local medical director must understand the unique challenges, issues, and needs of the industrial site. This can pave the way to working out ways to accommodate delivery of high-quality prehospital care by EMRs, EMTs, and paramedics who may work for the company or contractor and not for the local EMS providers that serve the general public. This may require that the industrial EMS system be licensed and regulated just as the other EMS provider organizations, but with special protocols, policies, and procedures as needed. This is similar to the different protocols, policies, and procedures often in place for the specialized needs of tactical and hazmat EMS crews.

### **International**

Given the diverse historical and cultural influences around the world, along with the broad spectrum of economic conditions that exist, it is no surprise that EMS is so different around the world. Perhaps more surprising, however, is how many elements are shared. Because so many of the challenges and issues facing EMS are universal, it is helpful to learn from international colleagues how they have approached the same needs with different methods.

There are two broad "models" for EMS staffing in different parts of the world: the Anglo-American and Franco-German models.

The Anglo-American model uses non-physicians to staff EMS units. Field care is usually limited to what is necessary to be done sooner than later, with as much as possible deferred until arrival at the hospital. Physician roles are generally limited to direct and indirect medical oversight. This is largely driven by the significantly higher cost of staffing field response units with physicians compared to EMTs and paramedics in the countries where the Anglo-American model is used.

In stark contrast, the Franco-German model relies heavily on physician-staffed field response units and emphasizes a



high degree of on-scene stabilization prior to transportation to the hospital. This is sometimes referred to as the "stay and play" model in contrast to the "scoop and run" philosophy of the Anglo-American model. The Franco-German model also affords a greater opportunity for treating and releasing some patients without transporting them to the hospital. Elements of this model are used in many countries in Europe. Europe generally has a less aggressive medical malpractice climate than the United States, and the providers are not as focused on defensive medicine. Many permit their dispatchers to screen and prioritize calls, frequently refusing ambulance transport and directing patients to alternative sites for care. The Franco-German model is also utilized in many areas of South America, particularly in Argentina, Chile, Uruguay, and Brazil.

In Europe, the costs of the EMS system are generally embedded in the overall costs of the various national health care systems. In South America, the costs of physician salaries are comparatively much lower than in the United States or Europe. This allows private ambulance companies to offer physician-staffed ambulances for high-acuity calls as well as physician-staffed sedans for lower-acuity house calls. These services are usually prepaid through service subscription programs for individual families, workplaces, shopping malls, or even places of business. There are also public EMS services, but they tend to have lower levels of funding and therefore tend not to offer the same level of response time performance or overall quality as the private subscription-based ambulance companies. The private companies will sometimes offer several different levels of service, based on the price level of the subscription.

Many EMS systems built around the Franco-German model are integrating other tiers of response that include EMTs and paramedics. A great example of blending the Anglo-American and Franco-German models occurs in The Netherlands, which has an advanced EMS system that resists characterization as either Franco-German or Anglo-American. At first glance, one might be tempted to label the Dutch as having an Anglo-American system because they employ paramedics. The paramedics are actually critical care nurses who have undergone additional training to become paramedics. In common with the Franco-German model, these paramedics can treat and release autonomously, and dispatch can choose not to send an ambulance. Dispatch, however, is not physician run, and physicians rarely venture into the field. It is a single-tiered response, a separate service in which the fire department assists only with rescue or extrication.

Aside from the financing methods and costs of physicians versus non-physicians, international EMS systems are also influenced by the different cultures and traditions of the areas they serve. In many parts of the world, ambulances are rarely used. Personal vehicles are traditionally used to take the ill and injured to clinics or hospitals. Social class and gender may also influence what type of care and the quality of care that is provided.

## Provider organization considerations

Within the United States and other parts of the world that have a similar Anglo-American EMS system staffing design, there are many different organizations that provide EMS. Each type of organization has several theoretically unique advantages and challenges that EMS system designers and medical directors should be aware of. These should be understood as theoretical differences because organizations of the same provider organization type can still be quite different depending on their leadership and specific organizational cultures.

### Fire department EMS

Due to the requirements already in place for fire departments to respond to structure fires within minutes, fire departments across the country, particularly career departments in larger cities, already have the manpower and infrastructure in place to get emergency personnel on the scene of a medical emergency within a few minutes of call receipt.

From an economic perspective, the dual-function firefighter/EMT or firefighter/paramedic provides a fire department with "two employees for the price of one." This versatility allows these departments to utilize these cross-trained, dual-function personnel on fire apparatus as both fire suppression and EMS resources (at a BLS or ALS level) for medical first response.

Some urban and suburban fire-based EMS systems have all or a very large percentage of their firefighters cross-trained as paramedics. On the face of the issue, it would seem better to have more than fewer paramedics. The counter-argument is that there are a limited number of high-acuity cases where paramedics have an opportunity to exercise their higher levels of clinical knowledge and skills. Without sufficient opportunity to use their knowledge and skills, the quality of paramedic care can suffer. This advocates for having a smaller cadre of paramedics who go to higher-acuity cases over a broader geographic area. This has been the approach used by the highly acclaimed fire-based paramedic program in the Seattle Fire Department for decades.

Fire-based medical first response is extremely cost-effective. The cost of adding medical equipment, EMS training, EMS supervision, and fuel and maintenance costs for going on EMS calls to a standing fire response system is minor compared to the investment in the manpower and infrastructure that has already been paid for by the community for fire protection. Unfortunately, these marginal costs usually have to be covered by tax revenues. Under current rules set by the Centers for Medicare and Medicaid Services, with few exceptions, patient transport is the only EMS service that is billable.

Another added benefit of fire-based EMS is the ability to more directly integrate medical care into rescue operations. At the scene of a complex rescue, medical care can be initiated while the patients are being disentangled, physically stabilized, or moved. It should be noted that some EMS systems train and equip non-fire EMS crews to provide most of these same types



of rescue services. Fire-based EMS personnel are already steeped in the incident command system, which is used to manage major emergency incidents of all types. The physical, mental, and philosophical integration of medical services into the emergency incident environment is one of the most compelling benefits of fire service-based EMS.

Fire-based ambulance service requires manpower and vehicles not already in place for fire suppression. This requires a significant additional investment. Manpower costs represent most of the cost for operating an ambulance service. Given the generally higher wage and benefits of firefighters compared to municipal, private, or hospital-based ambulance services, personnel costs for fire-based ambulance service tend to be more expensive.

Fire-based ambulance crews tend to have the same 24-hour shift schedules and work out of the same stations as the fire apparatus crews. This can severely limit flexibility in matching the number and placement of ambulances to parallel the generally predictable patterns of demand for ambulance service (commonly referred to as system status management, or SSM). Failure to use SSM in fire-based ambulance services can result in significant added operational costs compared to organizations that do. On the other hand, SSM intentionally limits the number of ambulances in service at different times of the day to match the historical demand level. Unfortunately, the timing of many types of spikes in demand is unpredictable, such as a large multicasualty traffic accident incident or disaster. SSM-based ambulance schedules may not have the same number of ambulances immediately available that a traditional fire-based ambulance staffing model, with its typically larger, and more expensive, reserve capacity, would. One example of this difference was the Northridge, California, earthquake of 1994. This earthquake struck at 04.30 hours on a holiday morning. If fire departments in the area had employed SSM, they would have been woefully unprepared to handle the incredible number of calls for service that flooded the dispatch center immediately after the earthquake struck. During the first 24 hours after the earthquake, LAFD's dispatch center received 3,358 emergency calls for service, compared to its daily average during that time of just over 1,000 calls.

Emergency medical services system design requires choices to be made. Some of them are fraught with potential controversy in which cost, service levels, and provider organization selections have to be balanced against each other in choices made by local officials. What may be affordable or politically acceptable in one community may not be in another. If a fire-based ambulance service can find creative solutions to overcome these challenges and effectively utilize its strengths to operate at a net profit, those profits can help offset the costs of its fire-based medical first response program.

Because the firefighting and EMS duties are very distinct, prospective personnel may have the desire and aptitude for one occupation but not the other. This can affect recruitment as well as morale and job performance once hired.

A concern of incorporating EMS into the larger fire service is that EMS may become the "step child" to fire. EMS must compete with fire suppression and prevention activities for budget funding. For the provider, working on the busy EMS units is often less desirable than suppression duty. In some services, the EMS role goes to the less experienced and less senior members of the fire service, reinforcing and perpetuating the perception that EMS is a less desirable role. Firefighting activities require great agility, strength, physical stamina, and teamwork. Major fires are relatively rare and the daily routine may include considerable downtime. Yet, the vast majority of fire department responses are for medical calls. The differences between fire and EMS responsibilities, together with long-standing fire department traditions, can lead to major cultural differences among these factions, which inevitably result in performance and management problems. In spite of these challenges, many communities are exceptionally well served by fire-based EMS programs.

### **Law enforcement EMS**

Law enforcement agencies offer many of the same logistical and operations advantages as fire department EMS services. Due to the requirements already in place for police departments to respond to crimes within minutes, police departments already have the manpower and infrastructure in place to get emergency personnel on scene of a medical emergency within a few minutes of receiving a call. A major difference between most police departments and fire departments is excess production capacity. Fire departments have fewer and fewer fires they need to respond to. Despite that trend, the manpower and infrastructure needed to get anywhere in their jurisdictions in a matter of minutes must remain in place to ensure life and property protection. That leaves time available for other missions, such as EMS, to make use of those expensive resources. In contrast, most police agencies have either a rising demand for service or the rate of decline is not enough to warrant a search for other duties to assume. This is why law enforcement EMS is much less common than fire department EMS.

Some smaller communities have smaller demand levels for police response, but need a certain number of officers on duty to provide adequate coverage to the entire area of the community. In those cases, communities may be interested in having their police departments provide medical first response services. Police department ambulance service is quite rare. The same type of cultural and prioritization issues that can impede fire department EMS can also affect law enforcement EMS.

Some communities have implemented a combined delivery of police, fire, and EMS response services into a single set of personnel, most commonly referred to as public safety officers. Getting a "three-for-one" employee has attracted strong support in those communities. The cultural and prioritization challenges can be further compounded when trying to meld three rather than just two organizations into one.

## Municipal EMS

The municipal EMS provider organization model is most prevalent in urban and suburban settings and where large geographic areas are under a single local government with the resources to fund EMS as a separate agency.

The municipal EMS chief or director may report directly to the head of the municipal government, public safety director, or public health director. This variation in reporting structure highlights some of the identity issues that municipal EMS agencies can have. Is EMS a public safety agency that should report to the public safety director? Is it a health care organization that should report to the public health department? In fact, EMS is a hybrid, which can be both a blessing and a curse.

Although municipal EMS agencies may be administratively independent entities, they must work closely with the other public safety and health care organizations to assure the provision of optimal prehospital emergency care. A survey of the largest cities in the US showed that fire departments provide first response in 99 of 109 cities, whereas transports are provided by fire departments in 37 of 107 cities (34.6%), private organizations in 36 of 107 (33.7%), and municipal EMS in 15 of 107 (14%) [6]. A variety of other providers, including hospitals, public utilities, volunteers, public, private, and police, makes up the remaining ambulance service provider organizations.

The primary advantage of the municipal EMS model is its ability to focus. The agency, its managers, and its providers all have the provision of out-of-hospital care as the primary mission and sole focus. From an agency perspective, all resources can be directed to providing efficient and high-quality patient care and transport. Although there may be competing needs, such as replacement of monitor-defibrillators versus rescue equipment, these are all among EMS-related items rather than different lines of service, such as replacement of ambulances versus ladder trucks. Policies, schedules, station and unit distribution, and dispatch protocols can all be developed to facilitate the most effective EMS operation without compromising to concerns for fire or police functions.

Managers of municipal EMS agencies are able to direct their attention and administrative efforts to one service line. Further, being separate from fire or police agencies, municipal EMS agencies can select managers who have qualifications, background, and expertise specific to EMS and prehospital care. They are often current or former emergency medical care providers, and so have a medical background that a supervisor or manager trained in another discipline may not possess. Theoretically, this provides them with a better understanding of the needs of the field provider and patient. In addition, their health care backgrounds may help with decisions related to quality improvement, quality of care, and the purchase of medical equipment.

Perhaps the most important advantage is that the field provider's only duty is to provide emergency medical care. Each dual-role provider must also be proficient in an additional role, such as firefighting or law enforcement, so training and

continuing education must be divided between two very different activities; the firefighter/paramedic must try to maintain proficiency in both firefighting skills and emergency care, for example. There is little overlap in the knowledge base and skill sets of these two distinct professions.

Perhaps the greatest perceived disadvantage of the so-called "third-service" (neither police nor fire) model is based on cost and financial efficiency. Legally, police and fire services must be provided and funded by local government. These agencies are well established in the governmental and public power fabric. The perception is that EMS can be more efficiently provided through incorporation into one of these two existing agencies, thus saving on infrastructure and personnel (both management and providers) costs. Typically, the fire department has a large budget, and government leaders are often pressured to preserve this budget despite the drastic reduction in fire calls over the past 20 years. EMS often does not enjoy this same political protection and may become the vulnerable target of cost reductions. This issue should be carefully evaluated, however, because EMS, in contrast to most fire departments, does generate revenues for its services and thus the net cost is much less than the budgeted expenditures.

Another potential disadvantage of the municipal EMS agency model is the need for integration and collaboration with other public safety agencies. In many municipalities, municipal EMS providers perform transport operations. First response is performed by another agency, most often the fire department. Therefore, a good relationship between the fire department and the municipal EMS agency is important. This is sometimes challenging, because the fire and EMS departments may be competing for municipal financing, and providers may have different salary and benefit structures. Although municipal EMS providers tend to run more calls than their fire counterparts, they are often paid less. Municipal fire departments are typically much larger than EMS agencies and as a result their unions and associations generally carry much more political weight.

Municipal EMS agencies may still suffer from a bit of an identity crisis with the media, government officials, and public. It is not unusual to see EMS providers described as firefighters, or lumped in with a group of other emergency responders. They are often not identified as distinct EMS personnel. Thus, EMTs and paramedics in municipal EMS agencies often fail to receive proper recognition for their efforts, even when heroic in nature.

## Private EMS

Each community has its own unique history and path for how its ambulance and rescue services started and evolved over time. In many communities, private companies have long-standing traditions of providing high-quality ambulance service. This can offer communities many advantages. If there are a sufficient number of ambulance transports in the community, the ambulance service can be operated profitably without financial subsidy from local government. Lower transport volumes may

necessitate some subsidy, but that may be preferable to the cost and financial risk of creating a government-operated ambulance service as a separate agency or within the local fire department. A private ambulance service takes the burden of managing and funding the ambulance service away from the government. In most states, government entities at some level still have the responsibility of assuring that ambulance service is delivered in compliance with applicable rules, regulations, and standards. This can be achieved in several ways.

Licensure is a mechanism by which an empowered governmental unit can establish minimum standards under which ambulance service must be provided. Any company that meets the licensure requirements can provide service. This has the advantage of simplicity but the risk of incurring the many downsides of multiple competing ambulance providers.

Franchising is similar to licensure but can limit the number of providers. It may also designate exclusive operating areas to prevent "call jumping" and other forms of inappropriate competition. Many communities choose to award exclusive franchises to a single provider, which completely avoids the issues of inappropriate competition and simplifies oversight and coordination. In the absence of retail competition and natural price and quality controls, the municipality then has to take on a more substantive regulatory role. When a community designates its local fire department or third service municipal agency to be the exclusive ambulance provider, it has essentially granted it an exclusive franchise. In many communities, the fire department or municipal ambulance service will have an exclusive franchise for presumed emergency calls received via the 9-1-1 system, but calls received via seven-digit phone numbers may be given to a private ambulance company.

There is an almost endless number of variations for blending governmental emergency services with private non-emergency service. A very common model has private ambulance services respond to 9-1-1 cases when the government service runs short on available ambulances. A common flaw in such arrangements is failure to have the same quality standards and controls in place for both government and private ambulance services. Patients should get equivalent quality of care regardless of which organization provides it.

A public utility model designates a single ambulance service provider to provide emergency and non-emergency services. The governmental unit does the billing. The governmental unit owns or is in a three-way lease for ownership of capital equipment. This allows the governmental unit to hire an ambulance service contractor to manage and staff the operation to specifications set in the contract. The contractor is paid a specified amount per call or by some other formula. If there is money left over after paying the contractor, that can be used by the governmental unit as it sees fit. The contractor can be readily replaced if needed for major breach of contract while leaving behind the capital assets. Under the public utility model, it is possible for governmental units to actually bid on the ambulance contract in competition with private services. For example, if a

county government is running the public utility EMS system, a city or consortium of cities could bid to provide ambulance service through their local fire departments.

The nature of the contractual relationship is important for the EMS medical director to understand. Ideally, the medical director should be somebody who is not beholden to the company, having been appointed by a third party (e.g. local government) and who is not directly compensated by the private company. Further, there is obvious benefit in medical director involvement in the structure of the contract. For example, the medical director ought to be in the best position to offer recommendations for response time standards and clinical capabilities. In any case, the EMS medical director should expect that he or she is going to be working within the confines of the established contract. Nothing more or less can be automatically expected of the private company.

At first blush, this seems rather onerous and inflexible. No doubt, at times it might be. Yet the contract should also establish some ground rules that make expectations of all parties more clear. Such clarity in relationships, which is really what is being discussed, can be refreshing and helpful when contentious issues arise.

All providers of EMS are undoubtedly, at some level, held to be fiscally responsible. A private provider will have motivation to sustain a profitable business. That is not necessarily a negative factor, for such goals can (and have in many cases) incentivize efficiency, innovation, and quality. These factors can all attract additional business opportunities.

For the EMS medical director, an advantage of working with a private provider can be the uniform focus on EMS. As with municipal third services, there is typically no distraction from other competing priorities or missions in the organization, unless the company is also running paratransit or related services. Accountability within the system may be easier to optimize than perhaps in cases involving governmental agencies and municipal employees. Clearly, relationships are key. First, the EMS medical director should seek to gain credibility as an authority with regard to the community's EMS issues. Second, he or she must have a synergistic relationship with the service's manager(s) that can only result from understanding each other's perspectives and priorities. That said, appropriately applied creativity, ingenuity, and expertise can result in a superior EMS system that often relies on collaborative partnerships with other public safety and health care entities to effect the timeliest response to emergencies and outstanding prehospital care.

Subsets within the realm of private EMS are hospital-based and volunteer EMS organizations. The key characteristic is not whether the organization is for profit or not for profit; it is more about being a unit of government or a non-governmental (i.e. private) enterprise.

Hospital-based EMS services have a significant advantage over their non-hospital-based counterparts in that they are part of a health care organization. This creates opportunities to leverage the clinical and cultural assets of the hospital to enhance

training, continuing education, professional development, career ladder options, etc. There are some legal ramifications of having a hospital-based ambulance service on billing and acceptance of patients. One of the downsides is that hospitals often do not have many of the specialized business and logistical competencies needed to manage an ambulance service. There can be an unfortunate tendency to treat the ambulance service like just another department of the hospital, despite its very unique demands and requirements.

Volunteer ambulance services and non-transport rescue squads are typically formed as not-for-profit charitable corporations under Chapter 501(c)(3) of the Federal Tax Code. It is important to recognize that many "volunteer" ambulance services actually pay their members to respond to calls, often a small amount per response. Some volunteer services have some paid staff working from the ambulance station during daytime working hours. The off-site volunteers cover calls at night and on weekends. This is a common transition pattern as communities will often outgrow a volunteer model as call volumes increase and become too burdensome for the volunteers to reliably cover on a 24/7 basis.

Regardless of what type of organization provides the ambulance service, EMS medical directors must continually insert themselves at the table with the policy and decision makers, speaking loudly for evidence-based medical care among the echoes of political and financial rhetoric.

## Unionized workforce considerations

Unionized employees tend to be more common in urban and suburban EMS systems. They present some distinct opportunities and challenges for administrators and medical directors. They can often provide a very effective means for communication with the field staff. Collective bargaining agreements with unions can also impose some restrictions in how policies that affect roles, responsibilities, and working condition issues are addressed. When a unionized workforce is present, the system design should recognize its presence and seek to include it as a resource for field staff input and participation, complementary to other mechanisms through the normal chain of command. An important factor is the status of labor/management relations, which can vary tremendously over time. When there is mutual respect and reasonable trust, the dialog can be very constructive and the union can be a strong partner in effecting positive change.

## Deployment planning

Deployment planning refers to the processes used to decide where and when ambulances and medical first response units are to be positioned while waiting for the next call. There are four general types of deployment planning: static, dynamic, real-time, and hybrid.

*Static* deployment is the simplest and most common. Response units are positioned 24/7 in stations. The locations of the stations are chosen strategically based on historical patterns of call locations and call timing. This is most commonly used by fire and municipal EMS services. It has the advantage of offering crews a comfortable location while awaiting their next call. Vehicles can also be kept in garages with shielding from the elements.

*Dynamic* deployment looks for geotemporal patterns of demand and develops a plan to make the most efficient use of resources to meet response time goals. Geographic analysis shows recurring patterns of *where* calls occur. That information is coupled with temporal or timing analysis to find patterns in *when* calls occur. The combined geotemporal analysis allows deployment planners to develop detailed contingency plans. At a very detailed level, each of the 168 hours in a week is analyzed separately for how many calls typically are in progress and where those calls tend to be located. Queuing analysis is used to determine how many units are needed to be available for that hour. A table is generated that shows where response units should be located depending on how many units are available during that hour. For example, queuing analysis might show that 17 ambulances are needed between 2pm and 3pm in the afternoon on Wednesdays. At some point, there might be eight units occupied on calls, leaving nine ambulances available. The table will show when nine ambulances are available, where they would be best positioned. Different tables may be generated for different months of the year. Special plans may be used during the timeframe when a special annual festival or sporting event takes place. This approach can be used for both ambulances and medical first response units. The primary advantage of dynamic deployment is that fewer hours of service from response units (called unit hours) are needed to provide the same level of response time performance compared to a static deployment strategy. This has huge potential for reducing the overall cost of the EMS system.

There are several pitfalls that must be addressed to use dynamic deployment safely and humanely. Dynamic deployment can save money by keeping crews busy during the entire shift, which increases their productivity for the costs of having them in service; however, keeping crews constantly busy without breaks and over longer periods of time creates a very poor work environment. A reasonable balance has to be achieved for long-term success. Analyses need to use good data and sound methods to yield good results. Bad data and unsound analyses can endanger patients by prolonging response times to time-sensitive medical problems. Competent dynamic deployment requires a much more sophisticated level of managerial expertise and data literacy compared to static deployment.

Technology is rapidly evolving to support increasing levels of sophistication in *real-time* deployment planning. Typically, deployment planners will develop a dynamic deployment plan as described. However, in real time, GPS location data from the ambulance can be combined with historical or real-time traffic

data that indicate traffic speeds. This allows the real-time analysis to show the effective range of each response unit on a map for a different response time. This appears on a computerized map as a polygon with gradations showing the area the unit can be expected to reach in 1-minute increments. The shape of the polygon changes as the unit travels (and as road conditions change if real-time traffic data are used). The dispatch center can then deviate as needed and appropriate to make adjustments based on real-time data. This is particularly helpful while units are moving from post to post or from hospitals to posts after calls.

*Hybrid* deployment uses combinations of these approaches. Many systems will have some fixed stations along with some posts at key intersections. Crews can be rotated to station posts for a break to stretch, eat, use the restroom, etc. Systems that cover urban, suburban, and rural areas will often use static deployment in the rural areas and dynamic deployment in the urban/suburban areas.

## Performance standards and assurances

Good EMS system design also sets standards and creates safeguards to help ensure compliance with those standards. System performance standards are primarily derived from patient and community needs, which must be balanced. For example, a small percentage of patients experience sudden cardiac arrest. This is an extremely time-sensitive emergency, with the chances of a neurologically intact survival falling by about 10% with each minute of elapsed time from collapse to initiation of resuscitation. For those patients who are lucky enough to have bystanders witness them collapsing in sudden cardiac arrest, having an EMS unit arrive within 1 minute of getting the call from the bystander would be great – but unaffordable. In practice, the decision is usually made considering what level of performance can be provided with available resources. If that answer is politically unacceptable for that community, more resources need to be allocated. There are usually very different levels of community acceptance and expectation for urban areas versus rural areas. In short, a community can have whatever level of performance it is willing to pay for. This is where system-level medical oversight is extremely important. The physician medical director needs to advise policy makers on the likely effect of response time performance, specific medical equipment, certification levels, etc. on clinical outcomes. Whenever possible, those recommendations should be based on sound medical evidence.

Historically, EMS system performance standards have focused on target response time intervals and the percentage of calls where those targets were met. This was due in large part to the very limited amount of scientific evidence that showed the relationship between clinical outcomes and response time intervals. For decades, the evidence was limited to cardiac arrest. The data show that the sooner EMS crews

can initiate resuscitation, the better the outcomes will be. There was also strong political momentum, but not much research, supporting the notion that getting patients to trauma centers sooner than later will improve outcomes. This led to a generalization that getting to EMS patients sooner rather than later was an appropriate surrogate measure of patient outcome and clinical quality. It had the convenient attribute of being relatively straightforward to measure.

Emergency medical services research has improved over time and we now have better information and technology. We have a growing body of peer-reviewed EMS research that shows that shortened response times do not have nearly as much effect on clinical outcomes as previously believed. For conditions other than sudden cardiac arrest, a few minutes sooner or later generally does not make a significant difference in outcome. This has huge financial implications for where response time intervals can be set without comprising care – with the exception of sudden cardiac arrest.

This is leading some systems to take a more creative and evidence-based approach to setting response time standards. For example, Kent County, Michigan, is considering relaxations in response time standards while simultaneously increasing efforts to utilize other municipal employees, delivery services, off-duty medical personnel, and citizen bystanders to start hands-only CPR to address the cardiac arrest cases in a more effective manner than primary reliance on EMS to initiate resuscitation. This has the potential to decrease the number of EMS response units needed to meet standards without compromising outcomes.

They are also shifting the focus from response time accountability to compliance with processes known to improve clinical outcomes, such as high chest compression fractions, shorter pre- and postdefibrillation pauses, earlier notifications and fewer false positives and false negatives on EMS STEMI alerts, and earlier notification and more reliable documentation of stroke scores.

Short response times have also been assumed to correlate with better patient satisfaction. While there probably is a correlation, it may not be a primary factor. Rather than relying on response times as a surrogate for patient satisfaction, there are ways to measure it directly and set standards for it.

## Transparency and accountability

Mechanisms for creating transparency and accountability for performance create powerful incentives for clinical and service excellence. When EMS providers are required by the system design to report their performance using valid and appropriate metrics, they will have a natural tendency to meet standards and improve over time.

Emergency medical services provider organizations should be held accountable for meeting fair and meaningful performance standards. Beyond the political capital and reputation loss for

failure to meet standards, the system design can impose penalties for chronic failure to meet standards. While this has been common for meeting response time standards, in light of more contemporary research, it might be better applied to clinical process performance metrics such as CPR quality. In extreme cases, the system design should have mechanisms in place to safely and appropriately replace a provider for chronic failure to meet standards.

Emergency medical services system design has enormous influence on clinical and service excellence. EMS leaders and policy makers should seek to master its concepts and methods as they seek to improve performance in their communities.

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