A Comprehensive Framework for Determining the Cost of an Emergency Medical Services System

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To determine the cost of an emergency medical services (EMS) system, researchers, policymakers, and EMS providers need a framework with which to identify the components of the system that must be included in any cost calculations. Such a framework will allow for cost comparisons across studies, communities, and interventions. The objective of this article is to present an EMS cost framework. This framework was developed by a consensus panel after analysis of existing peer-reviewed and non–peer-reviewed resources, as well as independent expert input. The components of the framework include administrative overhead, bystander response, communications, equipment, human resources, information systems, medical oversight, physical plant, training, and vehicles. There is no hierarchical rank to these components; they are all necessary. Within each component, there are subcomponents that must be considered. This framework can be used to standardize the calculation of EMS system costs to a community. Standardizing the calculation of EMS cost will allow for comparisons of costs between studies, communities, and interventions. [Ann Emerg Med. 2007;49:304-313.]

INTRODUCTION

Most Americans expect that a call to 911 for medical assistance will result in an immediate response, with the appropriate staff and equipment. Although throughout the United States most calls to 911 will result in a response, the staff and equipment that are sent to the scene will vary according to chief complaint and geographic location. The care emergency medical services (EMS) providers give when they arrive at the scene will depend on local resources and protocols.1

The care provided within EMS systems has come under increased scrutiny in recent years. Although few would argue against the need for these systems, many have questioned the value of the range of out-of-hospital care services currently provided.2–10 There are dramatic philosophic poles in this controversy. Some suggest a radical streamlining of EMS systems is necessary,1 whereas others advocate for a significantly expanded scope of services deployed in the out-of-hospital setting.11

Among many involved in the dialogue related to the use of health care resources, there is a persistent concern about the lack of proof of effectiveness for many out-of-hospital care interventions.12–17 Even for those interventions with proven efficacy, such as care of nontraumatic cardiac arrest18–23 and use of formalized trauma systems for severe trauma,24–30 little is known about their cost-effectiveness.31

Limited attention has been paid to the evaluation of the cost of EMS systems or the care rendered within them. A recent systematic review of the English-language literature revealed a paucity of investigations that evaluated the cost of EMS or the interventions provided.31 This review yielded only 32 studies that reported an analysis of the cost of out-of-hospital care, and the quality of the majority of these studies was inconsistent.

Any cost analysis should follow guidelines for the standardization of economic analyses such as those suggested by the Panel on Cost-Effectiveness in Health and Medicine.32

However, when a cost analysis of out-of-hospital care is conducted, there is also a need for a conceptual framework
specific to EMS to assist in the analysis. Use of such a framework will ensure that comparisons can be made across systems and across studies. To our knowledge, no framework exists that can be used by researchers, communities, or providers to determine the cost of an EMS system so that appropriate evaluations can be conducted. The objective of the EMS Cost Analysis Project is to create a comprehensive framework that allows users to determine the cost of providing out-of-hospital care from a societal perspective. This article presents the EMS cost framework that has been developed.

**DEVELOPMENT OF THE FRAMEWORK**

A panel (the authors) was assembled to generate an EMS cost framework. This team first developed a comprehensive list of all components of EMS cost (Figure 1). To initiate this process, each of the articles identified in the previously conducted literature review was analyzed, and a list of all the cost components used in those studies was generated (Table). Using the information generated from this review and their experience, the authors generated a comprehensive list of all the components of EMS cost from a societal perspective. A consensus process was used to generate the initial cost framework, in which all of the panel members had to agree whether each candidate item was included or excluded from the list. In preparing this list, the authors also enumerated each of the assumptions that were required to generate the list.

**Search for Existing Literature**

Once a preliminary list of EMS cost components had been generated, the authors searched for and reviewed any additional available materials that described the cost of EMS. This secondary search was conducted to identify any non-peer-reviewed literature. The search included a general Internet-based method, as well as requests to selected experts for any relevant information. The secondary search for other types of published documents yielded few items for review. However, a methodology for evaluating cost within an EMS system, developed by the American Ambulance Association, was identified. Although this methodology was designed for use by a single EMS agency and was not comprehensive enough for determining EMS costs from a societal perspective, it was used to refine the comprehensive cost framework.

**External Review**

The revised framework was sent to several outside reviewers from a variety of backgrounds (ie, EMS medical direction, EMS research, economics). The reviewers were asked to evaluate and comment on the framework, which included the list of cost components and a document describing related assumptions. The panel evaluated all outside reviewer comments and used the consensus process to finalize the framework.

**EMS COST FRAMEWORK ASSUMPTIONS**

The components of the cost of EMS are illustrated in Figure 1. There is no hierarchic rank to the components; they are all necessary. The full EMS cost framework is shown in Figure 2. The framework lists each component of EMS cost plus the factors that make up the components. Each of the factors must be considered and assigned a value to calculate the cost of the EMS system to the community it serves. To fully use this framework, one must understand the assumptions that were made during its development.

**Working Definition of an EMS System**

For the purpose of this framework, our focus was on the EMS system as it responds to acute, unscheduled health care delivered outside the hospital within the setting of a system that deploys health resources in response to a request for emergency medical care, which includes lay responders, public safety, and EMS providers who participate in this response and the system within which they respond. All types of vehicles involved in response are included: air, water, and ground. Further, this definition would include any unscheduled acute request for aid, regardless of whether it is through a public safety answering point or not (eg, interfacility transport of a trauma patient from an outlying hospital to a Level I trauma center) but would not include scheduled interfacility transports (eg, transport of a nursing home patient to a dialysis appointment).

**Intended Audience for the Framework**

The intended audience for this framework includes professionals involved in EMS operations, EMS policy, and EMS research, as well as the community, including government officials and policymakers. When costs are calculated, some items from this framework may not be included, depending on the perspective taken.
<table>
<thead>
<tr>
<th>Article</th>
<th>Cost-effectiveness Analysis</th>
<th>Cost Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altintas (1999)</td>
<td>Cost description</td>
<td>Capital costs; building costs, ambulance vehicle, service car, fixtures, and equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recurrent costs: personnel (physicians, nurses, drivers, and assistants), electricity, water, heating, cleaning, rental, insurance, tax, consumable medical materials, medications, radio repairs and maintenance, telephone fees and maintenance, ambulance engine oil, ambulance tire repairs, ambulance repairs and spare parts, ambulance gasoline, ambulance vehicle periodic controls, gasoline for service cars</td>
</tr>
<tr>
<td>Brady (1996)</td>
<td>Cost analysis</td>
<td>Used charges only</td>
</tr>
<tr>
<td>Brazier (1996)</td>
<td>Cost minimization</td>
<td>Aircraft, pilots, medical personnel, maintenance, landing facilities, and ambulance control staff involved in deployment</td>
</tr>
<tr>
<td>Bruhn (1993)</td>
<td>Cost analysis</td>
<td>Office utilities and rent, medical supplies (new), medical supplies (disposable), nonmedical supplies, maintenance, unexpected costs, insurance, vehicle fuel, training, vehicle lease, staff (nurses, paramedics, driver/pilot, clinical operations director, medical director, and office staff) salary and benefits</td>
</tr>
<tr>
<td>Bur (2001)</td>
<td>Cost outcome description</td>
<td>Hospital costs only</td>
</tr>
<tr>
<td>Cretin (1977)</td>
<td>Cost benefit</td>
<td>Provider salary and benefits, equipment, support personnel, maintenance and other costs</td>
</tr>
<tr>
<td>Daberkow (1977)</td>
<td>Cost description</td>
<td>Determined the cost of having a staffed facility using a National Highway Traffic Safety Administration report; then used a general cost per call, cost per mile driven, and a cost for supplies</td>
</tr>
<tr>
<td>De Wing (2000)</td>
<td>Cost minimization</td>
<td>Used charges by the agency</td>
</tr>
<tr>
<td>Fischer (2000)</td>
<td>Cost analysis</td>
<td>Marginal cost for running an ambulance continually for a year; average number of crew per ambulance and the proportion that were paramedic; annual ambulance leasing costs, which included maintenance and equipment, fuel costs for idling, cost of uniforms, administrative consumables, and additional insurance</td>
</tr>
<tr>
<td>Forrer (2002)</td>
<td>Cost-effectiveness</td>
<td>Instructor stipend, overtime for officer training time, equipment costs (defibrillator, battery, pads), equipment maintenance costs</td>
</tr>
<tr>
<td>Gearhart (1997)</td>
<td>Cost outcome description</td>
<td>Personnel (salaries, employee benefits, training expenses, Federal Aviation Administration–mandated physical examination, random drug and alcohol testing), capital, operations (fuel, maintenance contracts, spare parts, purchased services, and lease of a substitute aircraft during periods of major maintenance), medical supplies (liquid oxygen system, medications, and single-use patient care supplies), insurance (liability and aircraft hull), and administration (telephones, pagers, office supplies, advertising, computers, and interdepartmental hospital charges)</td>
</tr>
<tr>
<td>Hallstrom (1981)</td>
<td>Cost-effectiveness</td>
<td>No details provided</td>
</tr>
<tr>
<td>Hauswald (1997)</td>
<td>Cost outcome description</td>
<td>Personnel, ambulance purchase, maintenance, and minimal equipment</td>
</tr>
<tr>
<td>Jakobsson (1987)</td>
<td>Cost description</td>
<td>Price of defibrillator divided by estimated working life of 5 years. Cost of training was salaries of EMT and nurses and physician lecture fees.</td>
</tr>
<tr>
<td>Jermyn (2000)</td>
<td>Cost-effectiveness</td>
<td>Defibrillators, ancillary equipment, biomedical services for preventive maintenance on defibrillators, routine nonwarranty work, training equipment, trainer/provider certification, call review by medical control, attrition of providers and trainers</td>
</tr>
<tr>
<td>Kriegsman (1998)</td>
<td>Cost description</td>
<td>Fixed costs: salaries, benefits, overtime training, travel, training, administration, and equipment upgrade; Variable costs: expendable supplies, equipment wear and tear, and overtime responses</td>
</tr>
<tr>
<td>Kurola (2002)</td>
<td>Cost outcome description</td>
<td>No details provided</td>
</tr>
<tr>
<td>Lammers (1995)</td>
<td>Cost analysis</td>
<td>Marginal cost of ambulance service</td>
</tr>
<tr>
<td>Lechleuthner (1994)</td>
<td>Cost analysis</td>
<td>Pilot/driver, paramedic, physician, maintenance/technical (gas, inspection, leasing, depreciation, etc)</td>
</tr>
<tr>
<td>Nichol (2003)</td>
<td>Cost-effectiveness</td>
<td>Defibrillator, nontraditional responder training, instructor costs, retraining, drills</td>
</tr>
<tr>
<td>Nicholl (1994)</td>
<td>Cost analysis</td>
<td>Capital, paramedic crew, training, helicopter hanger, landing sites, equipment, lease, vehicle fuel, repair, and depreciation, ambulance controllers, headquarters, and other overhead</td>
</tr>
<tr>
<td>Omato (1988)</td>
<td>Cost-effectiveness</td>
<td>EMT training, ambulance, radio equipment, medical equipment (eg, stretcher, oxygen, first aid supplies), defibrillator, ultrahigh frequency radio for telemetry, and drug box</td>
</tr>
<tr>
<td>Pascarelli (1978)</td>
<td>Cost description</td>
<td>Mobile ICU, base station, defibrillation, salaries of personnel (supervisors and paramedics), expendable supplies (equipment and maintenance)</td>
</tr>
</tbody>
</table>
This framework is intended to be comprehensive. In some locations, listed services may not be present and can be ignored when cost is calculated. However, if the service is provided by another agency within the community, the cost should be considered even if it is provided with no charge.

**Perspective**

It is recommended that health economic evaluations be conducted from a societal perspective,\(^32\) which includes downstream health care costs, as well as other costs incurred by society. Here we report only considerations for calculating the cost of an EMS system providing out-of-hospital care to a community because the methodology for measuring the downstream costs of health care outside the EMS setting and societal costs such as lost wages are well described elsewhere (eg, Sloan,\(^34\) O’Brien et al,\(^35\) and Gold et al\(^32\)). The cost of EMS and the cost and effects of health care outside the EMS setting are not entirely independent. For example, an intervention provided in the out-of-hospital setting may reduce the cost of subsequent hospitalization. Users of this framework can adopt any perspective desired. They simply need to determine which components are appropriate for their analysis.

The cost of the EMS system to society is greater than the cost of maintaining a single EMS agency in a community (Figure 3). Not all of the items listed in this framework will be captured in an agency budget. Costs may be incurred by other sectors, with the benefit of some or all of those costs being reaped by the EMS sector. For example, use of radio infrastructure by a commercial ambulance service incurs costs, even if these are paid for by the municipality. The use of a societal perspective allows for comparisons across studies and communities and will help decisionmakers allocate limited resources within the EMS system, the general health system, or between the health system and other sectors of society.

**Costing Components of an EMS System**

Our primary focus was the description of methods of measuring EMS costs. These include the cost of readiness and actual service delivery. Readiness includes on-call staffing for coverage of the geographic service area. Service delivery includes staffing, durable and consumable equipment used to respond to the scene, provision of care on scene, and transportation to a receiving facility. The cost of training, retraining, quality management, medical direction, equipment, administration, housekeeping, and other expenses that are used to maintain the system are relevant. Once a community has calculated the cost of its system, it can attribute those costs to the cost of readiness versus the cost of patient care.

**Joint Production**

This framework is intended to estimate the cost of the entire EMS system and, as such, may require consideration of 1 or more of the various types of agencies that are part of a system (eg, fire departments, police departments, first-tier EMS agencies, second-tier EMS agencies). When cost is evaluated, care provided by each of these agencies must be taken into account (Figure 2). Some of the agencies involved in an EMS system have other responsibilities. For example, a fire department may respond to both fire and medical requests for aid. Allocation of the cost of being available to provide either of these responses is necessary to estimate the cost of the system. How to allocate such joint costs (products) is an area of considerable debate that cannot be resolved in this article. The decision to allocate costs (eg, capital, equipment, human resources) as a proportion of resources used is common. However, this decision is relatively arbitrary and without foundation in economic theory.\(^36\)-\(^38\)

**Charges versus Costs**

A cost reflects the actual resources consumed to produce a good or service. In contrast, a charge is the price paid for a good or service, which may or may not reflect the resources consumed.\(^39\) A charge includes the cost, taxes, and any profit that might be earned for goods or a service.

Often the charges the system pays for goods or services do not reflect the true cost. For example, a medical direction contract may be less than the actual cost of paying for the time that a physician spends performing medical director duties. Further, the opportunity cost of labor that is provided voluntarily must be accounted for by assigning the prevailing

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<tr>
<td>Riediger (1990)</td>
<td>Cost benefit</td>
<td>No details provided</td>
</tr>
<tr>
<td>Snooks (1996)</td>
<td>Cost description</td>
<td>Crew, out-of-hospital capital, helicopter operating costs, and special landing and patient transfer facilities</td>
</tr>
<tr>
<td>Suchard (1999)</td>
<td>Cost description</td>
<td>Amount of reimbursement by Medicare</td>
</tr>
<tr>
<td>Turner (2000)</td>
<td>Cost minimization</td>
<td>Consumable equipment and cost per minute on call</td>
</tr>
<tr>
<td>Urban (1981)</td>
<td>Cost-effectiveness</td>
<td>Paramedic training, equipment, vehicle, salaries, benefits, relief pay, supplies, support services, equipment, maintenance, dispatching, management, vehicle operation</td>
</tr>
<tr>
<td>Valenzuela (1990)</td>
<td>Cost-effectiveness</td>
<td>Personnel salary and benefits, training, equipment, maintenance, cost of adding one more unit to maintain response time</td>
</tr>
</tbody>
</table>
Human Resources: All personnel involved in organized EMS response, whether paid or unpaid, including any labor costs associated with the headings below (eg, fields providers, dispatchers, maintenance, billing, training personal)
- Salaries
- Benefits
- Overtime
- Training (overtime pay, stipend, etc)

Physical Plant (eg, 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 (eg, turnout gear, hazmat, infectious material protection), etc
- Durable (eg, 12-lead EKG machines, uniform)
- Acquisition
- Operation
- Maintenance
- Replacement
- Consumables (eg, oxygen, medicine, bandages)
- Acquisition
- Replacement (including caused by expiration)

Communications
- Public safety answering point equipment and facility
- Acquisition
- Operation
- Replacement
- Maintenance

Dispatch center
- Software (eg, 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 (eg, 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 [eg, 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 (eg, 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 (eg, instructor, location, durable and consumable equipment)
- Continuing (eg, 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 (eg community CPR defibrillation or first aid)
- Training (eg, instructor, location, equipment)
- Equipment
- Retraining

**Figure 2.** EMS system cost framework.
wage of the community, even if a nominal wage is being paid. Use of the prevailing wage in the community is usually the best method to calculate costs when the actual charges are not accurate. This information can be obtained from the United States Bureau of Labor Statistics (available at http://www.bls.gov/oes). This is an area of controversy in the economics field. There are other ways of dealing with this issue that depend on the perspective taken and whether workers must be replaced if they are not available.

Type of Cost
The cost framework includes broad components. Costs within these components may be fixed, variable, or quasifixed. Fixed costs are not responsive to production levels (e.g., the cost of building a fire hall is static regardless of how much it is used). Variable costs grow with higher levels of production (e.g., labor costs increase as more hours are worked). If there are only variable costs, at zero production the total cost will be zero. Quasifixed costs, or “sticky” costs, are a combination of fixed and variable costs, in which costs are flat in a certain range of production but jump to higher levels if certain thresholds are reached (e.g., improving response intervals by adding a staffed EMS vehicle because one can acquire whole but not partial vehicles).

DESCRIPTION OF THE EMS COST FRAMEWORK COMPONENTS
Human Resources
This component includes all personnel involved in the EMS system, whether they are involved in direct patient care or not. When considering human resources costs, one must consider salary, benefits, overtime pay, and the cost of training if it is paid for separately. These costs must be considered regardless of whether the position is paid or unpaid.

Physical Plant
This component includes any buildings that are necessary to train, provide, maintain, or administer the EMS system. When considering physical plant costs, one must consider the cost of acquiring, operating (e.g., utilities), maintaining (e.g., cleaning the gutters), and replacing the building.

Vehicles
This component includes any vehicles used by the EMS system, including ground-, air-, and water-based vehicles regardless of whether they are involved in direct patient care. Again, one would consider the cost of acquiring, operating (e.g., gasoline), maintaining (e.g., replacing the tires), and replacing the vehicles.

Equipment
There are 2 types of equipment considered in the framework: consumable and durable. Consumable goods are those intended for single use and subsequently discarded (e.g., oxygen masks, automated external defibrillator pads). For the cost of those items, one must consider only the cost of acquisition and replacement. However, these items may need to be replaced because of expiration, as well as use. Durable goods are those that can be used for multiple patients (e.g., automated external defibrillators, gurneys). Because they can be used multiple times, costing these items requires consideration of the cost of acquisition, operation, maintenance, and replacement.

Communication
Although communication costs could easily be accounted for by using the first 4 components of the framework, they have been listed as a separate component to ensure that all costs associated with communication are accounted for. Specifically, one must consider the cost of the equipment and facility for the public safety answering point, which means considering the human resources, building, vehicles, and equipment specifically related to the operation of public safety answering points in the community. Further, any dispatch center involved in EMS must be considered, regardless of whether it dispatches first responders or the transporting agency. In addition to the obvious building, equipment, vehicle, and human resources needed to run a dispatch center, one must also consider the cost of dispatch-related software and hardware. This component also requires consideration of all communication devices, including those in the vehicle, portable devices, and devices used for communication with receiving hospitals and online medical command. Finally, EMS communication infrastructure must be considered, but only those items that are specifically related to the emergency communications system and not those that can be considered sunk costs to society, such as common telephone lines and cell telephone towers.
Medical Oversight

Although this component could be considered under human resources, it was listed as a separate component because in many cases this may not be a traditional salaried position at a single agency. Personnel used for medical oversight may be employed by the EMS agency or they may be contracted for their services. Although contracting and outsourcing should be considered under each heading of the framework, it is common for medical oversight. Any personnel costs that are incurred through contracts must be included in addition to the cost of salaried or hourly personnel. Further, care should be taken to ensure that the actual cost of medical oversight services is considered, not just the charges, because some services may be provided for low or no cost in some locales. Further, when considering medical oversight one must consider the cost of quality assurance/quality improvement programs, as well as direct and indirect medical command.

Administrative Overhead

Administrative overhead also could be accounted for simply by using the human resource, building, vehicle, and equipment components. However, because many of these activities may not be immediately obvious, it was made a standalone component. The various categories to consider are listed in Figure 2. However, some special considerations are given for calculating the cost of insurance. The calculation of insurance costs is intended to be a proxy for the cost of compensating for adverse outcomes associated with misdiagnoses, mismanagement, or other types of damages.

Training

Training is composed of human resources, building, and equipment. Communities must ensure that they consider both initial and continuing training for their personnel.

Information Systems

Information systems include the cost of any computerized system. To account for these costs, one must consider the acquisition, operation, maintenance, and replacement of the system, including hardware and software. Further, these systems could be used for a variety of activities, from medical record management to billing. The cost of billing is included in this framework, although we recognize that some systems may not bill patients or third-party payers. Furthermore, billing is a method of generating revenue rather than a mandatory component of the EMS system. Therefore, the inclusion of this cost may be controversial.

Bystander Response to Medical Emergencies

Lay responders are defined as those who do not have a duty to respond but happen to be present at an incident. The costs associated with training, retraining, or equipping lay responders to participate in an organized response to acute, unscheduled health care delivered outside the hospital (eg, cardiopulmonary resuscitation [CPR] or first aid) are relevant to the cost of an EMS system whether the training or equipment is provided by an EMS agency or not. The presence or absence of these lay responses affects the cost of medical emergencies, as well as the effectiveness of responses to them, and should be included when the cost of an EMS system is calculated. The cost of these providers should be considered like a human resource, and their cost should be calculated with the prevailing wage, as described above. Public programs to modify risk factors or prevent acute health needs (eg, dietary modification, blood pressure screening) are not considered in this framework, because they are not part of our working definition of the EMS system.

EMS COST FRAMEWORK EXCLUSIONS

When the framework was designed, the following components were considered but excluded:

Taxes

The cost of paying taxes (eg, real estate and income) is not included in this framework, because they represent an income transfer rather than a true cost, that is, money is exchanged without any services relevant to EMS being provided (eg, the cost of service delivery in a public versus a for-profit system are similar, but the for-profit system charges more, in part because it has to pay taxes). Therefore, taxes are a charge rather than a true cost.

Medical Errors/Adverse Events

These were excluded because they are downstream costs. However, liability coverage and legal costs were included.

Sunk Costs to Society

These were excluded because even in a community without an EMS system, these costs would be expended. Examples of sunk costs include a community’s roads and regular communications infrastructure (eg, cell telephone towers, telephone poles). In addition, any new services built for the public good and not explicitly for EMS should also be excluded. However, new infrastructure built exclusively for EMS should be considered. For example, widening a highway solely so that EMS responders can pass traffic should be considered an EMS cost.

Prevention Costs

These were excluded because they fall outside the working definition of EMS. However, training of lay providers to provide emergency care (eg, CPR, first aid) was included because it would change patient outcome and EMS costs.

Standby (eg, Large Public Events or Special Weapons and Tactics [SWAT] Team Assistance) Costs

These may or may not be relevant, depending on how the service is provided. If standby services are provided by deploying system resources because there is a high likelihood of resource
Disaster Response
When providers respond outside of their own community, these costs should be excluded because they fall outside of our working definition of EMS for the community that the costs are being calculated for. However, the cost of supplies, training, etc, that are acquired in preparation for a local disaster should be included under the appropriate framework headings. Personal protective equipment that is purchased for medical responders should be included. However, equipment purchased for nonmedical responders should not be included. The cost for a hazardous materials team should be included and attributed according to the percent involvement in EMS.

Benefits of Interventions
This framework is intended to evaluate cost, but an economic evaluation should consider benefits as well. Benefits may be difficult to measure. For example, it is easy to identify the cost of improving patient discomfort, but the downstream effects may seem minimal in relation to cost. However, the importance of evaluating nonmortality outcomes is gaining momentum in the literature.40-44

How much a society is willing to pay for EMS will vary among communities and depends in part on total funds available. Therefore, different communities might be willing to pay more or less for out-of-hospital care, depending on their available resources and the competing alternatives within the community, which makes it difficult to create a universal definition of what incremental cost should be considered a decisionmaking criterion for EMS. It also means that the cost of readiness may be higher in some communities compared with others because of their system demands (eg, minimum response intervals).

It is beyond the scope of this article to discuss methods for measuring the effectiveness of interventions in an economic evaluation. These measures are well described elsewhere.32-35

OTHER FACTORS THAT MAY INFLUENCE COST Disparities
Cost-effectiveness can be affected by the incidence of a clinical entity within a population. Thus, the cost-effectiveness of implementing an intervention in a high-risk community may be different from that of a low-risk community. People in disadvantaged communities could be more likely to access EMS. For example, disparities in incidence and outcomes for cardiac arrest and trauma are observed across socioeconomic gradients, as well as across geographic regions.45-51 Cardiovascular disease is the leading cause of income-related differences in premature mortality in the United States52 and Canada.53 Also, the burden of injury is greatest among individuals of low socioeconomic status.54 Non-Hispanic blacks bear a disproportionate burden of morbidity and mortality caused by cardiovascular disease and injury.55 These disparities may be caused by differences in genetic risk, health behaviors, educational attainment, socioeconomic disadvantage, access to preventive care, or other variables. The costs, effects, and incremental cost-effectiveness of implementing or maintaining EMS services may differ between high-risk and low-risk populations.

Heterogeneity
EMS agencies can be vastly different from one community to the next. Communities have a wide variety of staffing models and system designs. The effectiveness of a given intervention can be highly variable between agencies.20 This heterogeneity can make it difficult to determine overall cost for a given community if a single methodology is used. Therefore, this framework is designed to be flexible for use across a wide variety of communities and EMS system types.

DISCUSSION
To calculate costs in an economic evaluation of care provided by EMS, one should determine the societal costs, including the direct costs of EMS and all other health care services provided to the patient, as well as the indirect costs of the patient’s injury or illness (eg, lost productivity). There is a good body of literature available to assist a researcher in determining the costs of other health care services and the societal costs of a particular disease or injury.32,34,35 Therefore, we developed a framework solely for calculating the cost of EMS while recognizing that the cost of EMS must be combined with other information to conduct a robust economic analysis.

Although other authors have attempted to calculate the cost of EMS, no standardized methodology has evolved (Table), which makes it difficult to compare results across studies or communities. To our knowledge, Figure 2 is the first attempt to create a standardized EMS cost framework from the societal perspective.

As the cost of providing out-of-hospital care continues to rise and funding for EMS remains flat or even decreases, new skills, technologies, and interventions continue to be introduced to the market. Communities and EMS agencies are faced with the need to determine the costs of their mission so that they can optimize patient outcomes, given their resources. Those who attempt to use the existing literature related to the economics of EMS will find few studies. Furthermore, methodologies used to conduct the studies are inconsistent and, in some cases, inappropriate.

We recognize that the development of this framework alone will be insufficient to foster high-quality economic evaluations in EMS. Although this macro-level framework is necessary for
nurturing this nascent field, there is still a need for the development of micro-level frameworks that detail the steps to costing each aspect of the various EMS system designs. Finally, the authors believe that this framework was developed with the best available resources, but it has not yet been validated. The framework requires testing in various types of EMS systems to verify that it is comprehensive enough to be meaningful and flexible enough to be usable.

CONCLUSION

This framework can be used to standardize the calculation of EMS system costs in a community. Researchers, policymakers, and EMS providers can use this framework. Standardizing the calculation of EMS cost will allow comparisons of costs between studies, communities, and interventions.

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