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SPECIAL CONTRIBUTION

An Economic Toolkit for Identifying the Cost of Emergency Medical Services (EMS) Systems: Detailed Methodology of the EMS Cost Analysis Project (EMSCAP)

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Abstract

Calculating the cost of an emergency medical services (EMS) system using a standardized method is important for determining the value of EMS. This article describes the development of a methodology for calculating the cost of an EMS system to its community. This includes a tool for calculating the cost of EMS (the ''cost workbook'') and detailed directions for determining cost (the ''cost guide''). The 12-step process that was developed is consistent with current theories of health economics, applicable to prehospital care, flexible enough to be used in varying sizes and types of EMS systems, and comprehensive enough to provide meaningful conclusions. It was developed by an expert panel (the EMS Cost Analysis Project [EMSCAP] investigator team) in an iterative process that included pilot testing the process in three diverse communities. The iterative process allowed ongoing modification of the toolkit during the development phase, based upon direct, practical, ongoing interaction with the EMS systems that were using the toolkit. The resulting methodology estimates EMS system costs within a user-defined community, allowing either the number of patients treated or the estimated number of lives saved by EMS to be assessed in light of the cost of those efforts. Much controversy exists about the cost of EMS and whether the resources spent for this purpose are justified. However, the existence of a validated toolkit that provides a standardized process will allow meaningful assessments and comparisons to be made and will supply objective information to inform EMS and community officials who are tasked with determining the utilization of scarce societal resources.

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To date, limited research has been done to determine the cost-effectiveness of emergency medical services (EMS). In addition, the work that has been done has not used standardized methods for calculating costs.[1] With growing concerns over the financial burden of health care, the cost of prehospital care is receiving increasing scrutiny. In this environment, determining which prehospital interventions to deploy within a community requires information about both the effectiveness of potential interventions and the cost of

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deployment.[2] Since societal resources are limited, questions of how best to spend health care dollars and whether to shift funds from prehospital emergency care to other societal needs are likely to become more pointed and persistent. Properly answering these important questions can only occur with robust evaluations of the economics of EMS that use a standardized conceptual model for calculating cost.[3]

In 2007, the EMS Cost Analysis Project (EMSCAP) developed and published a framework for determining the cost of an EMS system.[4] However, this work did not include an operational toolkit or methodology for calculating the cost of an EMS system to the community it serves. Such a toolkit would allow cost–benefit, cost–utility, and cost–effectiveness analyses of EMS care to be conducted in a standardized manner. This paper describes the development of a methodology for calculating the cost of an EMS system to its community. This includes a tool for calculating the cost of EMS (the ''cost workbook'') and detailed directions for determining cost (the ''cost guide''). The process used for the toolkit's development is consistent with current theories of health economics, applicable to prehospital care, flexible enough to be used in varying sizes and types of EMS systems, and comprehensive enough to provide meaningful conclusions.

METHODS

To develop the cost workbook and guide, the previously published EMS cost framework was used as a foundation.[4] The same EMSCAP investigators considered how to calculate cost for each component of the framework. These components include administrative overhead, bystander response, communications, equipment, human resources, information systems, medical oversight, physical plant, training, and vehicles.

To ensure that the process for calculating costs was realistic and could be used in diverse settings, three communities were recruited to be part of a pilot process for developing the toolkit. These communities were Livingston County, New York; the Oshkosh Region of Wisconsin; and Richmond, Virginia. These communities represent rural, suburban, and urban areas. They include volunteer, paid, and combination EMS agencies, both fire department and third service-based. Table 1 provides a more detailed description of the three communities and their EMS systems.

Representatives from each of the communities participated in the EMSCAP workgroup deliberations regarding the design of the cost workbook and guide. They also used the workbook, following the directions in the guide, for their community. Any issues encountered during this process were discussed by the entire research team. Based on this input, the cost workbook and guide were modified during the course of the project. This ensured that the process for completing the workbook was applicable in the ''real world.''

The goal of the toolkit is to describe and estimate the cost of an EMS system for a defined geographic area. In general, it is intended to be used to determine cost from a societal perspective, accounting for all costs, no matter who pays them. While the Panel on Cost-Effectiveness in Health and Medicine has recommended that all health economic evaluations be conducted from a societal perspective,[5] the toolkit was designed to have the flexibility to be used to determine the cost of an individual agency, a group of agencies, a portion of a system, or even something as simple as the incremental cost of a single intervention. Thus, the workbook can be used to calculate costs from multiple perspectives.

For the purpose of this project, an EMS system was defined as all of the agencies that participate in acute, unscheduled health care outside the hospital within a defined geographic region. As such, the costs of all agencies and services that are part of a community's EMS system are included. Collecting costs is difficult and labor-intensive. Therefore, the workbook was designed to capture the best estimate of EMS system costs while not being so burdensome that it is impractical for a system to use.

RESULTS

This project developed an EMS cost toolkit that consists of a cost workbook and guide. Both are available free of charge at: http://www.mcw.edu/emergencymed/FacultyResearch/SelectedResearch/EmergencyMedicalServicesCostAnalysisProject.htm.

A modular approach was used to design the toolkit. That is, a different process was created to determine

Table 1
Description of the Three Pilot Communities

Characteristic	Livingston, NY	Oshkosh, WI	Richmond, VA
Population	65,000	100,000	200,000
Number of calls/year	10,000	6,000	50,000
Volunteer	Several EMS agencies staffed by volunteers and some staffed by a combination of volunteer and paid providers.	None	8% of calls staffed by a single volunteer agency
Dispatch system	Medical priority dispatch	Medical priority dispatch	Medical priority dispatch
Medical oversight provided by	Contract	Contract	No online medical direction, guided by protocols
Average response time	12 minutes	10–12 minutes	9 minutes
Fire department provides first response	Yes	Yes	Yes

the cost of each type of agency (e.g., EMS, fire, communication center, hospital) and each agency of that type within the community has its costs calculated. This modular approach lends itself to determining the cost of an EMS system from several perspectives (e.g., societal, EMS system) using the same workbook. The workbook is completed using a series of steps. Each of the required steps will be briefly described.

Step 1: Define the Community for Which Costs Are Being Calculated

This step defines the boundaries of the community for which costs are to be calculated. This could be within government-defined city or county limits, a system-defined region (e.g., nine communities that work together to respond to the area's EMS needs), or some other definable geographic area. This decision is based solely on the goals of those conducting the analysis. However, whatever boundaries are chosen must be adhered to throughout the analysis. That is, to calculate cost from a societal perspective, all relevant costs for delivering EMS services within the selected boundary must be included, no matter who pays those costs. In addition, any costs for responses outside of that boundary must be excluded, no matter who pays those costs. Throughout this discussion, it is important to note that the term ''cost'' always means actual cost and should not be represented by surrogates such as charges or reimbursement.

Step 2: Determine All of the Agencies That Are Part of the EMS System

Next, every agency that contributes to the EMS system within the community should be identified. These agencies may not directly participate in patient care and may not be what would traditionally be called an ''agency.'' For example, a state agency may provide communication equipment or a police department may provide a training facility. The cost of the EMS contribution for each agency should be calculated. Table 2 provides a list of agency types that should be considered. If there are multiple agencies of a specific type in a community, the cost for each agency of that type should be calculated separately.

When identifying which agencies to include, certain considerations should be made. For example, the cost of communication may be spread over several agencies. Communication includes, but is not limited to, primary and secondary public safety answering points and operational communications. If communications infrastructure is paid for by an agency that provides no other EMS services, the cost of those communication services should still be included. For example, if state law enforcement provides repeaters, the cost of the portion of that equipment or service that is used by EMS should be included in the cost calculation.

The costs of hazardous materials (hazmat) or other specialty teams (e.g., swift water rescue, high angle rescue, structural collapse) may be difficult to determine because they may reside within a listed agency or may be a separate agency altogether. However, because hazmat and other specialty team activities can be expensive, and only a small proportion of their activities are related to EMS, only the percentage involved in EMS should be included rather than the entire cost of the service, regardless of whether it is provided by a traditional EMS provider. Consideration of which specialty response teams to include should follow this general rule: if a non-EMS agency is performing its traditional role, these costs or activities should not be included or separated out as a specialty team. For example, if a fire department responds to a fire where a patient is trapped inside, the cost of removing that patient should not be attributed to EMS, since the fire agency was performing its traditional role. However, the cost of heavy rescue equipment used to extricate a patient entrapped in a vehicle after a crash should be considered, as well as the cost of providing patient decontamination.

While downstream costs (i.e., health care provided after EMS care) are part of any economic analysis, the goal of this tool is to standardize the calculation of EMS system costs. Therefore, the cost of an EMS system should not consider downstream costs, such as the time a person resuscitated from cardiac arrest spends in the intensive care unit. However, this does not mean that there are not hospital costs that must be included. Hospital costs should account for any EMS-specific goods or services that are provided by local hospitals. Only the cost of EMS-related items or activities should be included. It is not necessary to account for the cost of hospital care of EMS patients or any other function the hospital provides for the community. However, if replacement equipment is given to EMS by a local hospital, then this cost should be included. Hospital costs that might be considered include linen, medication, or other ''exchange programs,'' medical oversight, or communication devices provided by the hospital.

Double-counting of costs should be avoided. For example, a physician, nurse, or other health care provider may provide time for direct (on-line) and/or indirect (e.g., creating protocols, serving on oversight committees) medical oversight. The cost of this time should be accounted for even if provided by individuals working in an emergency department while also performing clinical duties. The cost of any donated, volunteered, or uncompensated time should also be included. However, if a local EMS agency contracts with the hospital for medical oversight, this cost should be

Table 2
Types of Agencies That Should be Included in the Cost Workbook

EMS (i.e., ground ambulance service)
Police department
Fire department
Air medical or other specialty transport service (e.g., boat transport)
Communication center
Public health agency
Specialty teams/hazardous materials
Hospital
Community disaster preparedness
Shared system services
Bystander training

accounted for only once in the workbook and not counted twice as a contract cost for EMS and a personnel cost for the hospital. Contract charges may not compensate for the actual time provided, but may pay for less time. In this case, the actual total costs should be accounted for rather than just the contract cost.

Community disaster-preparedness is a good example of the importance of considering costs only within the defined boundaries of the community for which cost is being calculated. The costs of preparedness operations being supplied by non-EMS agencies should be considered. These costs could include emergency operations centers, a specialty community disaster response team, or other related activities. This should include any extra equipment, personnel, building space, etc., used solely for the community's medical response to a disaster. The distinction between what is ''medical'' versus ''nonmedical'' may not always be apparent. However, in general, the costs associated with being prepared for the care of a patient during a disaster or other major event (e.g., triage tags, patient stretchers) should be included.

Step 3: Estimate the Percentage of Time That Each Agency Is Involved in EMS

A given agency might serve several roles within a community where costs of EMS are being calculated (e.g., a fire department might provide EMS and fire suppression). Furthermore, an agency might provide EMS services outside of the community for which costs are being calculated. Including the total cost of an agency in either scenario would overestimate the cost of the EMS system, while ignoring it would underestimate the costs. To address this issue, the total cost of the agency (excluding any segments of the agency that have no EMS role as described in Step 1) must be calculated. Then, only the percentage of the cost that represents the EMS role in the defined geographic region should be included in the final system calculation. It should be noted that the calculation of this percentage is controversial. The simplest case would be to include 100% of the agency's cost. However, this would only be accurate if its role is solely EMS-related. Therefore, a method for determining the percent devoted to EMS must be selected. The EMSCAP team suggests four possible ways to calculate this percentage (Table 3). However, there are numerous other methods that could be used. The guide recommends a method for each agency type, but the workbook allows the user either to determine the percentage or to use the predetermined option.

Step 4: Select a Year

To make the cost data obtained during the costing process comparable from year to year or across agencies/communities, it is important to consider in what year the costs were incurred. To complete the workbook, a year must be selected for calculating costs and, whenever possible, the cost of an item should be obtained for the selected year. However, when this is not possible, the workbook allows designation of the year for which the costs are being entered. Based on this information, all costs are then adjusted to the same year, using Consumer Price Index calculations published by the Bureau of Labor Statistics.

Step 5: Calculate Human Resource Costs

To account for human resources costs, all work roles and work types used by an agency must be considered. This includes those who provide direct patient care as well as those who have support roles. For example, an EMS agency might have many levels of care providers, administrators, dispatchers, mechanics, and clerical staff. For each type of employee, the total number of hours worked in a year should be reported, along with the average hourly wage and hourly benefit for that role. In addition, some agencies use volunteers to provide services. Although the agency does not pay for these providers' time there is a cost associated with their efforts and it should be considered. To determine the wages of a volunteer, the prevailing wage in the community should be used as the salary for that position.

Step 6: Calculate Physical Plant Costs

The physical plant costs are those related to all buildings that are used to house and support any activities related to an agency. Types of physical plant buildings include (but are not limited to) training facilities, stations to house response vehicles and personnel, maintenance garages, and administrative offices. The original cost and year of purchase should be determined for each building. The cost and year of any renovations should also be determined. If there were multiple renovations of the same building, include all renovations from the past 15 years. The workbook calculates either

Table 3
Suggested Methods for Calculating Percent Involved in EMS

Option 1	Number of EMS calls taken in the community being costed	÷	Total number of calls taken by the agency	Attribute readiness time across all functions based on volume
Option 2	Time on EMS calls taken in the community being costed	÷	Total time on calls taken by the agency	Attribute readiness time across all functions based on time
Option 3	Time on EMS calls taken in the community being costed	÷	Total time available for calls	Attribute readiness time to other functions only
Option 4	(Total time available for calls) – (Time on non-EMS calls and calls taken outside the community being costed)	÷	Total time available for calls	Attributes all readiness time to EMS

economic or accounting depreciation for building costs. It uses 30 years as the life span for the building structures and 15 years for renovations.

For a building that is shared, the percentage of the building that is devoted to the agency should be determined by calculating the square feet devoted to the agency being analyzed and dividing by the total square feet of the building. If determining the cost of a single service provided by that agency, then the percentage of the building that is devoted to that specific EMS-related service is calculated. For a rented or leased building, the annual cost for the lease/rental should be included. Finally, the yearly cost for utilities (e.g., electricity, telephone), janitorial services, maintenance, and insurance for the EMS portion of the building should be determined.

Step 7: Calculate Vehicle Costs

''Vehicle'' refers to all modes of transport used by the agency. These could be used for EMS response, direct patient transport, or other EMS-related purposes. It is important to ensure that all types of vehicles are included (e.g., fire apparatus, quick-response vehicle, bicycle). If the vehicle is owned, the average cost and life span for a vehicle of that type should be included. If vehicles are routinely sold or traded in after the agency-defined life span, then the purchase price should be the average purchase price minus the average sale price for a used vehicle of that type. For each vehicle type, the annual fuel, maintenance, and insurance costs should be determined.

Step 8: Calculate Equipment Costs

Equipment includes those things that are used for direct patient care as well as items that are used to support the agency (e.g., administrative computers, dispatch consoles). If any tax is paid in the purchase of equipment, this should be deducted when calculating the cost.

For consumable equipment, the annual cost of units used or discarded due to expiration or damage should be determined. When calculating the cost of durable equipment, the average purchase cost and life span and the average yearly maintenance costs should be identified. If equipment is sold at the end of its life span, the cost should be decreased by the resale value.

Step 9: Calculate Other Administrative Costs

Any shared or contracted services the agency uses that have not been accounted for in the previous steps should be identified in this step. This includes services such as human resources management by an outside agency, information technology services, legal services, or laundry service. Caution should be used not to double count costs that have already been considered.

Step 10: Calculate EMS-related Training Costs

The EMS-related training provided by the agency should be separated into initial and continuing training. Initial training is defined as any EMS-related training that is new to the student (e.g., paramedic training for an EMT-Basic or CPR training for police recruits). Continuing training is defined as any EMS-related training that is a refresher for the student (e.g., renewing CPR certification). The costs for the basic medical education of medical oversight physicians, fire suppression training of fire fighters, etc., should not be included. However, the specific EMS education for physicians, fire fighters, or others should be included. For each type of training, the annual training fees, space rental fees, equipment rental fees, and the cost of printing and duplication of training materials should be considered.

Step 11: Calculate Bystander Training Costs

To estimate bystander training costs, the total number of people in the community who take programs such as CPR training, public access defibrillation training, or ''First There First Care'' courses during a year and the average cost to train a single person in those courses should be determined. These training courses are primarily intended to train lay responders to enhance the EMS system. All courses provided in the community should be included, not just those taught by the identified agencies that are involved in EMS.

An important part of bystander cost is the equipment used by bystanders. The number of public access defibrillators available in the community should be determined as well as the average cost.

Step 12: Exclude Any Costs Associated With Revenue Generation

Any costs related solely to revenue generation should be excluded. While revenue generation is important to maintaining an agency, these costs are excluded because they are an income transfer. They are not a cost of delivering EMS services. Further, it would be too difficult to fairly represent these costs across all agency types (e.g., billing, tax levies, grants). No matter what type of agency is being considered (e.g., municipal, commercial), any revenue-generating activities such as billing, lobbying, or fundraising should be excluded. This includes the human resource costs of billers as well as their office space, equipment, and software costs.

DISCUSSION

This article describes the development of a toolkit for calculating the estimated cost of a community's EMS system. The use of three communities to pilot test this methodology ensured that this was not simply an academic endeavor, but that this methodology could be used in the real world. It would be impossible to calculate true costs without significant financial, time, and human resources commitments. Therefore, the proposed process balances feasibility and accuracy.

There are many pitfalls in calculating EMS costs. Some agencies that contribute resources to EMS may simply not be able to calculate their costs. This may be due to a lack of available data or a lack of personnel to provide a full accounting of costs. Certain types of agencies may have more difficulty providing this information than others, creating a potential reporting bias. Therefore, every effort should be made to get complete data from each agency. A key factor will be to

determine, in advance, that appropriate resources are available to each agency, because this process requires a significant commitment of time and effort.

This methodology requires that data be provided from a variety of sources. There are many political implications for these calculations: the various agencies providing costs may have competing interests and desire to show higher or lower costs depending on those interests. If the realistic cost of an EMS system is to be determined, all agencies must participate in the process and make the data available using similar procedures. It is also advisable to have a single person oversee the entire process to ensure that all costs are included appropriately, definitions and perspectives are represented consistently, and no cost is double-counted.

A key area of controversy is determining the percentage of total costs to attribute to EMS when a single agency serves a variety of roles in a community. In economic terms, this is called ''joint production.''[6] For example, a community may send a crew on fire apparatus to a request for medical aid. While this specific apparatus is not required for the medical response, it may be considered an efficient deployment strategy in a given setting. Thus, including a portion of the high-cost fire apparatus represents a true accounting of EMS costs for that community. However, if a large proportion of the responses for this apparatus are medical in nature, attributing a large percentage of the vehicle cost to EMS may be seen as inappropriately increasing the EMS costs and decreasing fire costs. Many would consider this a reasonable argument, because the main purpose for having this high-cost vehicle is being prepared to respond to fires and because the fire apparatus would be purchased and deployed as a community resource regardless of whether it is used for EMS calls or not.

This is further complicated by determining how to attribute the cost of readiness. All agencies must be ready to respond whenever a request for aid is received. However, there will always be times when there are no requests and crews and equipment are idle. There is a cost for that idle waiting time that must be considered. For a multipurpose agency such as a fire department, a decision must be made as to how the cost of idle time should be attributed: as a shared expense with EMS or as a fire department expense. If the expense is shared, then a fair distribution of the cost between the two missions must be determined. How these costs are attributed has political implications for budgets and corporate or governmental planning. The toolkit recommends a methodology for attributing these costs. However, it is recognized that this will be considered controversial, and ultimately will require agreement by the leaders of vested interests in a community, before the analysis can be completed.

The implications of this work are far-reaching. The methodology provides a standardized process and approach for calculating the cost of an EMS system and establishes a framework for conducting cost-related research. In addition, it also allows communities and agencies to be compared based on cost. While this potentially provides an important advance in an arena that many officials and researchers have hoped would be developed, it may also raise political, budgetary, or public relations concerns among EMS agencies and decrease their interest in participating. Furthermore, the findings may affect future funding of EMS activities. For example, when the entire cost of an EMS system becomes apparent to a community, leaders may decide to redirect some of those resources to other important needs. On the other hand, given the general sense of importance that is provided by the EMS ''safety net,'' officials may determine that the marginal costs of having a state-of-the-art EMS system are well worth the investment. The EMSCAP methodology allows such discussions to be based on objective and methodologically sound reasoning, rather than merely the opinions and perspectives of competing interests and agendas.

Finally, it is important to note that this toolkit is for the determination of EMS costs. If an economic evaluation of patient care is being conducted, then EMS costs as well as the cost of all of the other health care services that are provided must be considered in that evaluation.[3] There are other resources for calculating other health care service costs, so this toolkit does not address them.[5,6] Further, as with any science, there are continuous efforts to improve the process for evaluating health care costs. The toolkit, with some minor adjustments, provides the resources to consider costs from many perspectives and will be useful for numerous types of analyses.

CONCLUSIONS

The discussion of health care costs has taken center stage in our society.[7] This has highlighted the need to be able to identify cost for the various components of the health care system. There will be increasing pressure in the future for EMS systems to objectively show their value to the community. The ability to link costs to outcomes and lives saved is becoming an essential need for the maintenance and further development of EMS systems.[8] The proposed methodologic approach and costing toolkit are a significant step forward in this endeavor. There are many areas of controversy related to this work. However, by standardizing the process of identifying cost, it allows meaningful comparisons to be made, based on similar assumptions. The EMS Cost Analysis Project toolkit will be an asset to EMS and its future development.

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