Economic Value of Out-of-Hospital Emergency Care: A Structured Literature Review

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Study objective: The evaluation of the impact of out-of-hospital emergency care is a relatively new research focus. As such, there is a compelling need to determine how finite health care resources should be used in this setting. The objective of this study is to conduct a structured review of published economic evaluations of out-of-hospital emergency care to assess its economic value.

Methods: A structured literature search and structured review of articles pertaining to the economic value of out-of-hospital care was performed. The bibliographic database MEDLINE was searched for pertinent English-language articles published between 1966 and 2003. The search used the medical subject headings "emergency medical services" and "emergency medical technician" and was limited to the subheading "economics" and crossed with the medical subject heading "economics." The titles generated by this search were systematically reviewed and limited by topic. Abstracts from the identified titles were reviewed to select a final set of pertinent articles. These articles were further limited based on explicit inclusion and exclusion criteria. Authors used a previously published structured evaluation tool to review the final set of identified articles for quality and content.

Results: The initial MEDLINE search identified 3,533 citations. From this set, 535 potentially relevant abstracts were reviewed. From the abstract review, 46 articles were identified, along with an additional 14 from searching the secondary references. Of these 60 articles, 32 met the review inclusion criteria and were subjected to a full structured review. These studies predominantly addressed the cost of cardiac arrest (n=13, 41%), major trauma (n=8, 25%), and emergency medical services treatment in general (n=8, 25%). Only 14 studies considered the costs and consequences of competing alternatives. Of these, 2 were cost-benefit and 12 were cost-effectiveness evaluations. Two of the 14 studies met all 10 criteria for high-quality economic evaluation, whereas 2 others met none.

Conclusion: There is a paucity of out-of-hospital care literature that addresses cost and economic value. The extant literature is limited in scope, poor in quality, and evaluates small subsets of out-of-hospital emergency care costs. Favorable cost-effectiveness has not been firmly established for most aspects of out-of-hospital emergency care. [Ann Emerg Med. 2006;47:515-524.]

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INTRODUCTION

Background

Although few would argue the need for out-of-hospital emergency care within a community, which services and resources should be provided and rapidity of response are topics of considerable debate.[1–5] As new technologies and skills emerge, decisions about which services a community should provide become even more difficult. Recent studies such as the Ontario Prehospital Life Support project have evaluated the effectiveness of several out-of-hospital interventions.[6–8] However, determining which out-of-hospital interventions to use within a community is more than merely a matter of efficacy and effectiveness. To properly make this determination, cost and cost-effectiveness must also be considered.

Out-of-hospital emergency medical services (EMS) is a relatively young field. Therefore, the level of research has been nascent.[5,9] The natural evolution of research can be thought of as a continuum from laboratory to efficacy to effectiveness research. Economic evaluations done in a variety of settings are at the end of this continuum.[6] Once effectiveness has been established and there are at least 2 competing alternatives, economic evaluations are used to determine which alternative is more desirable from a cost perspective. There are myriad out-of-hospital care activities that need to be evaluated from a cost perspective to assist communities in determining how their finite resources should be used.

Interest in out-of-hospital care is high, as evidenced by the recent creation of an out-of-hospital subcommittee for the committee on the Future of Emergency Care in the United States at the Institute of Medicine.[10] Simultaneously, health care costs are increasing at alarming rates.[11] In the case of out-of-hospital emergency care, a significant proportion of this cost is often paid by taxpayers, who subsidize the out-of-hospital emergency care system to maintain its availability. For example, in Los Angeles the Reason Public Policy Institute found that the cost per patient transport was $476, and, because of a low rate of fee collection, there was a $12 per-capita tax subsidy required to maintain the system.[12]

The current study was conducted to determine the evidence available on the cost of out-of-hospital emergency care in general, as well as various out-of-hospital interventions. The objective was to systematically review published economic evaluations of out-of-hospital emergency care in order to assess its economic value.

		Are both costs and consequences considered?		
		No		Yes
		Examines only consequences	Examines only cost	
Is there a comparison of 2 or more competing alternatives?	No	Outcome description	Cost description	Cost-outcome description
	Yes	Efficacy or effectiveness evaluation	Cost analysis	Full economic evaluation *Cost minimization *Cost-effectiveness *Cost utility *Cost-benefit

Figure 1. Method of categorizing full economic evaluations and partial evaluations. By permission of Oxford University Press. Adapted from *Methods for the Economic Evaluation of Healthcare Programmes, 2nd edition*.[13]

MATERIALS AND METHODS

Data Sources

A structured literature search and a structured review of articles pertaining to the economic value of out-of-hospital emergency care were performed. The initial phase consisted of a search of the bibliographic database MEDLINE to identify relevant English-language articles published between 1966 and 2003. An initial set of references was developed by searching for the medical subject headings "emergency medical services" and "emergency medical technician." These medical subject headings were limited to the subheading "economics." A second search was conducted by not limiting the medical subject headings and cross-referencing them by using the "and" command, with a third medical subject heading "economics." A secondary review was then performed by searching the reference sections of all identified articles for additional relevant articles.

Study Selection

A single investigator (E.B.L.) reviewed this initial set of reference titles to identify those articles that potentially addressed the cost or economic value of out-of-hospital care. Titles for which it was obvious that out-of-hospital emergency care was not addressed were excluded. We created a working definition of "out-of-hospital emergency care." It was defined as acute, unscheduled health care delivered outside the hospital by a system that deploys health resources in response to calls to a public safety answering point.

Any title that failed to indicate that a cost or economic evaluation was conducted was excluded. However, to ensure that no relevant articles were missed, any title that could possibly contain a cost or economic evaluation of out-of-hospital emergency care was included for further review.

The abstracts of the selected reference titles were obtained and reviewed by 2 investigators (E.B.L., R.F.M.). Abstracts that indicated that the manuscript might discuss some aspect of the evaluation of out-of-hospital care from a cost or economic perspective were included for further analysis. Again, any questionable abstracts were retained for further review.

The full articles for the selected abstracts were retrieved and reviewed. A single author (E.B.L.) reviewed all of the manuscripts and selected those that met the study definition of out-of-hospital emergency care. Editorials, non–peer-reviewed reports, and review articles were excluded, as well as strictly methods articles. Several investigators (E.B.L., R.F.M., H.G.G., D.W.S.) read the remaining articles and categorized them into 3 groups by using a consensus process. Each categorization was discussed until there was unanimous agreement on all decisions. The categories were those that did any type of cost analysis, those that mentioned the word "cost" but failed to analyze costs, and those that had no mention of cost. The reference sections of all articles that were reviewed were hand searched for additional relevant articles.

Data Extraction

All articles that reported economic analyses of out-of-hospital EMS were evaluated using a previously published checklist for assessing economic evaluations developed by Drummond et al.[13] Before the checklist was applied, the articles were classified by whether they were full or partial economic evaluations and by the type of economic evaluation (Figure 1). Drummond defined economic evaluations as full evaluations if they compared the costs and consequences of 2 or more competing alternatives.[13]

Four types of full economic evaluations were considered: cost-benefit, cost-effectiveness, cost utility, and cost minimization. In a cost-benefit analysis, consequences are measured in dollars. In a cost-effectiveness analysis, consequences are measured in natural units such as the amount of disability or health care resources consumed. In a cost-utility analysis, consequences are measured in quality-adjusted life years (some authors consider a cost-utility analysis to be a cost-effectiveness study with a more comprehensive outcome that accounts for both the quality and quantity of life).[14] A cost-minimization analysis compares 2 competing alternatives with equivalent outcomes to determine which results in the lowest cost. Cost minimization can also be considered a form of cost-effectiveness analysis in which the effectiveness of the competing alternatives is equivalent.

Once the type of evaluation was identified, all references were assessed with a checklist for assessing economic evaluations described by Drummond et al[13] (Table 1). This checklist was selected because it is comprehensive and widely accepted in the field of health economics.

RESULTS

Data Synthesis

The initial MEDLINE search created a reference set of 3,533 references (Figure 2). From this set, 535 references were selected for abstract review, and of these, 46 were selected for a complete manuscript review. Searching the reference sections of selected manuscripts identified an additional 14 references. Of these 60 articles, 32 met the review inclusion criteria and were subjected to a full structured review by several authors (E.B.L., R.F.M., D.W.S., H.G.G.) (Table 1).

Of the 32 studies identified, only 14 were full economic evaluations.[15–28] Of these evaluations, 2 were cost-benefit analyses.[15,16] The remaining 12 studies were some form of cost-effectiveness study. Three were cost-minimization analyses.[17–19] Three studies used quality-adjusted life years as the outcome.[20–22] The remaining 6 studies were traditional cost-effectiveness studies that described the outcome in natural units, primarily cost per life saved.[23–28]

Eighteen of the 32 studies were identified as partial economic evaluations. Eight were cost descriptions: they examined only the cost of 1 alternative, there was no comparison, or the consequences or outcomes were not considered.[29–36] Four were cost-outcome descriptions, meaning that they examined only 1 alternative but considered the costs and the consequences of that alternative.[37–40] Six were cost-analyses because they examined the cost of 2 alternative treatments but not the consequences.[41–46]

Using the checklist for economic evaluations, the investigators evaluated how well the articles met the checklist criteria (Table 1). Two of the 14 full economic evaluation studies met none of the 10 checklist criteria,[15,17] whereas 2 of the studies met all of the checklist criteria.[19,21] The others covered various amounts of the checklist criteria.

Among the 32 studies, 13 (41%) addressed interventions for cardiac arrest, 8 (25%) investigated major trauma (1 study addressed both cardiac arrest and major trauma), and 8 (25%) investigated the general cost of an EMS system. Of the 14 full economic evaluations, 9 (64%) addressed cardiac arrest and 3 (21%) studied major trauma. There was 1 partial analysis that specifically addressed pediatric patients.

Among the 14 full economic evaluations, 4 reported that they calculated costs from the societal perspective. The remaining 10 studies did not clearly state the perspective they were using. However, it appears that 4 used a societal perspective and 6 used the EMS perspective in calculating costs. In terms of comparing the outcomes of the 14 full economic evaluations, only 9 studies reported which calendar year's dollars were used to calculate costs, thus making difficult the comparison of the other 5 studies to each other or other economic evaluations of interventions (Table 2).

Among the 10 analyses in which cost per life saved could be compared, we observed large variations in estimation of cost per life saved, reflecting differences in the comprehensiveness of the costs included, as well as the nature of the interventions considered and their estimated effectiveness. These studies evaluated a range of EMS interventions for cardiac arrest. Using the available data, we next estimated cost per life saved expressed in 2005 dollars (Table 3). For studies that did not state the year of data collection, we assumed that costs were calculated in the year of publication. Insufficient data were available on cost per life saved to include any of the other identified studies in this analysis.

DISCUSSION

Only 32 studies that were economic analyses of out-of-hospital care could be identified by rigorous evaluation of the past 38 years of peer-reviewed health care literature. In general, economic evaluations are most useful when there is evidence that an intervention is effective. Only a handful of out-of-hospital interventions have been proven unequivocally to be effective.[5,47,48] The paucity of science about the effectiveness and cost of out-of-hospital EMS dramatically compromises the ability of communities to optimize the use of limited health care resources.

This comprehensive review yielded only 14 full economic evaluations. The majority of studies were partial economic evaluations that failed to compare competing alternatives or to consider both the costs and consequences of the interventions. Although partial evaluations have some utility, the optimal purpose of an economic evaluation is to assist in making choices

Table 1. Structured review of articles using the check list for assessing economic evaluations published by Drummond et al.[13]*

First Author (Year)	Type of Analysis	Well-defined Question	Comprehensive Description of Competing Alternatives	Effectiveness Established	Important and Relevant Costs and Consequences for Each Alternative	Costs and Consequences Measured Accurately in Appropriate Physical Units	Costs and Consequences Valued Credibly	Costs and Consequences Adjusted for Differential Timing	Incremental Analysis of Costs and Consequences of Alternatives Performed	Allowance Made for Uncertainty in the Estimates of Costs and Consequences	Presentation and Discussion of Study Results Include All Issues of Concern to Users
Riediger (1990)[15]	Cost benefit										
Cretin (1977)[16]	Cost benefit	✓	✓		✓	✓	✓	✓	✓	✓	✓
De Wing (2000)[17]	Cost minimization										
Brazier (1996)[18]	Cost minimization		✓	✓		✓	✓				
Turner (2000)[19]	Cost minimization	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nichol (2003)[20]	Cost utility	✓			✓	✓	✓	✓	✓	✓	✓
Nichol (1996)[21]	Cost utility	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nichol (1998)[22]	Cost utility	✓	✓		✓	✓	✓		✓	✓	✓
Jermyn (2000)[23]	Cost-effectiveness	✓	✓	✓		✓	✓	✓		✓	✓
Ornato (1988)[24]	Cost-effectiveness		✓								
Urban (1981)[25]	Cost-effectiveness	✓	✓	✓	✓	✓	✓	✓			✓
Hallstrom (1981)[26]	Cost-effectiveness	✓	✓	✓					✓		
Forrer (2002)[27]	Cost-effectiveness	✓	✓			✓				✓	✓
Valenzuela (1990)[28]	Cost-effectiveness	✓	✓	✓			✓	✓	✓		
Suchard (1999)[29]	Cost description		✓								
Rosemurgy (1993)[30]	Cost description										
Daberkow (1977)[31]	Cost description										
Pascarelli (1978)[32]	Cost description										
Kriegsman (1998)[33]	Cost description										
Altintas (1999)[34]	Cost description										
Snooks (1996)[35]	Cost description										
Jackobsson (1987)[36]	Cost description			✓							
Kurola (2002)[37]	Cost outcome description										
Gearhart (1997)[38]	Cost outcome description	✓		✓		✓	✓	✓		✓	✓
Bur (2001)[39]	Cost outcome description			✓							
Hauswald (1997)[40]	Cost outcome description			✓							
Brady (1996)[41]	Cost analysis										
Lammers (1995)[42]	Cost analysis	✓	✓	✓		✓				✓	✓
Fischer (2000)[43]	Cost analysis	✓	✓							✓	✓
Lechleuthner (1994)[44]	Cost analysis	✓	✓								
Bruhn (1993)[45]	Cost analysis	✓	✓								
Nicholl (1994)[46]	Cost analysis	✓	✓								

*Checkmarks indicate that the criteria were present.

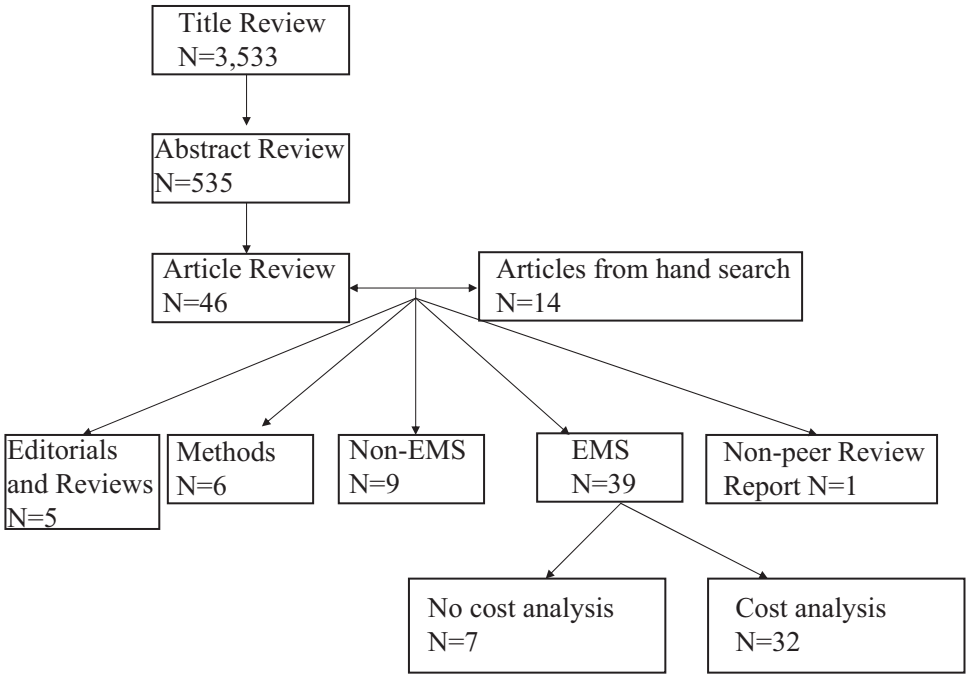

Figure 2. Article analysis.

about the use of community resources.[13] Therefore, accurate assessment of the economics of EMS care requires full economic evaluations.

Only 8 of the 14 full economic evaluations met a majority of the criteria for a high-quality analysis. Therefore, there are even fewer studies in the medical literature of sufficient quality to truly assist community decisionmakers. These findings support our initial hypothesis about the near absence of high-quality out-of-hospital-care economic analyses. EMS cost analyses must follow guidelines for the standardization of economic analysis, such as those suggested by the Panel on Cost-effectiveness in Health and Medicine,[14] but there is also a need for a conceptual framework specific to EMS to assist EMS researchers in designing and reporting economic evaluations.

The existing full economic evaluations primarily analyzed cardiac arrest and major trauma. These 2 areas account for only a small percentage of adults transported within the EMS system and an even smaller proportion of pediatric patients transported.[49] Therefore, the existing economic literature applies to only a small proportion of patients treated by EMS providers. To meaningfully assist communities in determining how their limited resources should best be used, the scope of economic analyses in out-of-hospital emergency care needs to be expanded and the quality improved.

How much a society is willing to pay for EMS will vary between communities and depends, in part, on total funds available. Therefore, different communities are likely to be willing to pay for out-of-hospital care according to their available resources and the competing alternatives, making it difficult to create a universal definition of what incremental cost should be considered a decisionmaking criterion for different EMS systems. It also means that the cost of readiness may be higher in some communities compared to others because of their system demands (eg, minimum response times).

Finally, because of the heterogeneous nature of out-of-hospital emergency care agencies, the effectiveness of a given intervention can be highly variable between agencies.[50] This factor makes it difficult to determine overall cost-effectiveness for a given intervention across all out-of-hospital emergency care agency types.

To our knowledge, this is the first comprehensive literature search on the economic evaluation of out-of-hospital emergency care. It included an objective assessment of the literature conducted by multiple authors using previously validated criteria for identifying high-quality analyses. The state of the literature on economic evaluation of EMS is poor.

Recommendations

Future evaluations of the economics of out-of-hospital emergency care interventions should apply rigorous methods to define the population under consideration, the intervention, what it is being compared to, the perspective of the study, the effects of the intervention and its alternatives, and their costs.[14]

LIMITATIONS

This study was a comprehensive literature search that applied a priori qualitative criteria. However, it had several limitations. The existing literature is sparse. It is available for only a few

Table 2. Results of the full economic evaluation studies.

Article by First Author	Type of Evaluation	Perspective	EMS Cost Factors	Year in Which Dollars Are Expressed	Conclusion
Riediger (1990)[15]	Cost benefit	Not stated, appears societal	Few details given	Not stated	EMS saves $44.3 million per year to the community, and the cost-effective ratio for EMS is 5.3.
Cretin (1977)[16]	Cost benefit	Not stated, appears societal	Attendant salary and benefits, equipment, support personnel, maintenance, and other costs	Not stated	It costs between $3,141 and $6,100 per added year of life for a mobile coronary care unit, depending on how the cost is discounted.
De Wing (2000)[17]	Cost minimization	Not stated, appears agency	Used charges by the agency	Not stated	There is a 7- to 8-fold increase in charges for helicopter transport compared to ground transport. There is a potential $500,000 saving over 2 years if ground transport used instead.
Brazier (1996)[18]	Cost minimization	Not stated, appears societal	Aircraft, pilots, medical personnel, maintenance, landing facilities, and ambulance control staff involved in deployment	Fiscal year 1991–1992	The incremental cost of helicopter transport was $1.97 million annually.
Turner (2000)[19]	Cost minimization	Not stated, appears societal	Consumable equipment, cost per minute on call	Fiscal year 1997–1998	No statistically significant difference in cost between the 2 groups.
Nichol (2003)[20]	Cost utility	Societal	Defibrillator (cost depreciated), nontraditional responder training (including instructor costs), nontraditional responder retraining (including cost of drills)	2003	Nontraditional responders had an incremental cost of a median $56,700 per QALY gained.
Nichol (1996)[21]	Cost utility	Societal	911 Service, ambulance communication center, ambulance bases, vehicles, equipment, wages, benefits, and education	1991	Incremental cost of adding more EMS providers in a single-tier EMS system was $368,000 per QALY. In a 2-tier system in which more BLS is added, the cost is $53,000 per QALY if they respond in fire department pump vehicles or $159,000 per QALY if respond in ambulances. Changing from a 1-tier system to a 2-tier system was $40,000 per QALY in a pump vehicle or $94,000 per QALY in an ambulance.
Nichol (1998)[22]	Cost utility	Societal	AED annual training, AED maintenance, police defibrillator	1996	Incremental cost of PAD by lay providers was $44,000 per QALY or $27,200 per QALY when PAD was provided by a police officer.
Jermyn (2000)[23]	Cost-effectiveness	Not stated, appears agency	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	1996 Canadian dollars	Cost per life saved in an urban area was $6,776; $49,274 for a rural area.

Table 2. (continued).

Article by First Author	Type of Evaluation	Perspective	EMS Cost Factors	Year in Which Dollars Are Expressed	Conclusion
Ornato (1988)[24]	Cost-effectiveness	Not stated, appears agency	EMT training, ambulance, radio equipment, medical equipment (eg, stretcher, oxygen, first aid supplies), defibrillator, UHF radio for telemetry, and drug box	Not stated	Total initial training personnel and equipment cost per life saved from ventricular defibrillation was $7,687 for a basic EMT, $2,125 for an EMT-D, and $2,289 for a paramedic.
Urban (1981)[25]	Cost-effectiveness	Societal	Paramedic training (depreciated during 5 years), equipment, vehicle (depreciated during 2–5 years), salaries, benefits, relief pay, supplies, support services, equipment, maintenance, dispatching, management, vehicle operating and maintenance	1978	The marginal cost per life saved was between $6,521 and $42,358 for a suburban paramedic program in regard to cardiac arrest.
Hallstrom (1981)[26]	Cost-effectiveness	Not stated, appears agency	Could not be determined	Not stated	For an EMT-only system, the cost-effectiveness (calculated as cost in thousands of dollars divided by percentage of cardiac arrest patients discharged alive) was 52.6 for an EMT defibrillation program and 25.6 when a paramedic fly car was added.
Forrer (2002)[27]	Cost-effectiveness	Not stated, appears societal	Defibrillator training costs included the instructor stipend and overtime for officer training time. Equipment costs included the cost of the defibrillator, battery, pads, and other miscellaneous equipment. Miscellaneous costs included equipment maintenance costs.	1999	The cost per life saved as a result of decreasing time to first shock with a PAD program was between $23,542 and $70,342, with a cost per year of life saved of between $1,582 and $16,060.
Valenzuela (1990)[28]	Cost-effectiveness	Not stated, appears agency	Cost included 4 items: personnel costs, which were the dollar difference between ALS and ILS personnel salary and benefits; training costs, including the cost to train an ALS provider per year; equipment costs, including the cost of maintaining monitor defibrillator units on all vehicles; maintaining response time, which was achieved by adding 1 more unit.	1989	The cost per year of life saved was $8,886.

EMS, Emergency medical services; *QALY*, quality adjusted life year; *AED*, automated external defibrillator; *PAD*, public access defibrillator; *EMT*, emergency medicine technician; *EMT-D*, emergency medicine technician-defibrillator; *ALS*, advanced life support; *ILS*, intermediate life support.

Table 3. Summary of published economic evaluations of EMS interventions for cardiac arrest, with all results adjusted for inflation.

First Author (Year)	Intervention	Comparator	Perspective	Costs Included	Incremental Cost: Effectiveness, $/Life Saved
Nichol (1996)[21]	Reducing response time for cardiac arrest	Existing EMS agency	Society	EMS and initial hospital costs only; not ICD or ambulatory costs	In all-ALS system by adding ALS providers: $2,627,00 In BLS+ALS system by adding defibrillator-capable first responders in: fire vehicles: $383,500 EMS vehicles: $1,134,400 Changing from an all-ALS system to a BLS+ALS system by adding defibrillator-capable first responders in: fire vehicles: $286,900 EMS vehicles: $678,2000
Ornato (1988)[24]	Treatment by range of EMT	Existing EMS agency	Agency	Training costs only	EMT: $12,900 Defibrillation-capable EMT: $3,600 Paramedic: $3,800
Urban (1981)[25]	Advanced cardiac life support	Existing EMS agency	Societal	EMS and initial hospital costs only	$91,900
Valenzuela (1990)[28]	Advanced cardiac life support	Existing EMS agency	Agency	Training, equipment, and on-time costs	$181,000
Jackobsson (1987)[36]	EMTs	Existing EMS agency	Societal	EMS and hospital only	$2,800
Jermyn (2000)[23]	First-responder defibrillation	Existing EMS agency	Agency	Training and consumables but not capital equipment	In urban setting: $7,800 In rural setting: $57,400
Hallstrom (1981)[26]	Defibrillation	EMTs without defibrillation	Agency	EMS costs assumed	By EMTs: $48,100 By EMTs with paramedic backup: $80,900
Forrer (2002)[27]	Defibrillation	Existing EMS agency	Agency	Training and equipment but not medical oversight or quality assurance	By police: $84,000
Nichol (1998)[22]	Defibrillation	Standard EMS agency	Society	EMS and hospital but not ambulatory or ICD costs	By police: $107,000 By lay responders: $190,000
Nichol (2003)[20]	Defibrillation	Standard EMS agency	Society	EMS, hospital, ICD, and ambulatory costs	By security guards in casinos: $183,000

BLS, Basic life support; *ICD*, implantable cardioverter-defibrillator.

interventions. The methods used were variable between studies, complicating our ability to pool the results meaningfully. Comparisons were even further complicated by the variability between studies in terms of time and place.

Our search was limited in that we restricted it to only published English-language literature because of the expense of translation and our inability to identify unpublished studies. Further, because an expert panel conducted this review, it is limited by the biases inherent in a review by only a handful of individuals. However, because consensus required unanimity among all the reviewers and explicit review criteria were used, these biases were limited.

CONCLUSION

In conclusion, there is a paucity of literature that addresses the economics of out-of-hospital emergency care. The existing literature is of poor quality, limited to a narrow scope, and does not reflect the broad array of care provided within EMS systems. A conceptual framework for evaluating costs and consequences of care delivered in the out-of-hospital setting is needed. Future studies should evaluate the costs and consequences of out-of-hospital interventions by using high-quality methods. Only with the development of the methodologies for this purpose will the much-needed understanding of how to optimize EMS care be possible.

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