Effectiveness of emergency medical services for victims of out-of-hospital cardiac arrest: a metaanalysis
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Authors' objectives
To determine the effect of differences in response time, proportion of bystander CPR (cardiopulmonary resuscitation), and type and tier of emergency medical services (EMS) system on survival after out-of-hospital cardiac arrest.

Searching
MEDLINE was searched from 1966 to August 1992, and bibliographies of retrieved articles were examined. The search strategy is given.

Study selection
Study designs of evaluations included in the review
Any study design was eligible for inclusion, though the studies meeting the inclusion criteria were all case series.

Specific interventions included in the review
EMS providing out-of-hospital cardiac care. This could include basic life support, defibrillation, and advanced life support.

Participants included in the review
Patients undergoing cardiac arrest out of hospital were included.

Outcomes assessed in the review
The proportion of patients surviving to hospital discharge was assessed.

How were decisions on the relevance of primary studies made?
The papers were independently reviewed by two authors, and any differences were resolved by discussion.

Assessment of study quality
The quality of the included studies was not assessed, although a funnel plot was carried out to determine the effect of sample size on effect size, in order to determine the effect of publication bias.

Data extraction
The data were independently extracted twice and then assessed for accuracy.

Methods of synthesis
How were the studies combined?
A generalised linear model was used to examine the effect of the independent variables on the proportion of individuals surviving to hospital discharge. The independent variables were: proportion of bystander CPR, response time interval, and type of EMS system. This latter variable incorporated the type of care, with whether a one- or two-tier system was involved. In the one-tier system, a single provider and vehicle type responds to medical emergencies with either basic life support (BLS), BLS plus defibrillation (BLS-D), or advanced life support (ALS). In a two-tier system, the first respondent provides BLS or BLS-D, while a second responder then provides ALS.

How were differences between studies investigated?
In addition to the funnel plot analysis, secondary analyses were carried out to determine the effect of the outlying and influential studies on the results.
Results of the review
Thirty-six studies describing 41 EMS and including 23,313 cardiac arrests met the inclusion criteria.

Greater survival to discharge was associated with shorter response time (p<0.01), and with two-tier as opposed to one tier EMS (p<0.01). The proportion of patients receiving CPR was negatively associated with survival to discharge (p=0.04). However, this was felt to be due to the significant (p=0.02) interaction between this variable and response time interval. Absolute changes in probability of survival to discharge were also calculated. After adjustment for other variables, survival was 5.2% in a one-tier system, compared to 10.5% in a two-tier system. A 1-minute decrease in mean response time was associated with an absolute increase in survival of 0.4% in a one-tier system and 0.7% in a two-tier system. A 5% increase in bystander CPR was associated with an absolute increase in survival of 0.1% in a one- or two-tier system. Exclusion of outliers and influential studies from the model did not affect the results of the primary analysis, and the funnel plot revealed no evidence of publication bias.

Cost information
A cost-effectiveness analysis was reported elsewhere (see Other Publications of Related Interest).

Authors' conclusions
Decreased response time and the use of two-tier as opposed to one-tier EMS systems may be associated with greater survival. However, evaluation of the evidence is difficult because of inadequacies in the data.

CRD commentary
The authors themselves give full details of the problems with this analysis. One problem is that all included studies are case series; randomised controlled trials (RCTs) would provide the most accurate estimate of the effectiveness of the different EMS systems, but no RCTs met the inclusion criteria. In addition, the two-tier studies are mostly from two geographic areas, and the one-tier studies are mostly old. However, this meta-analysis is valuable in that it highlights problems with existing studies and specifies the further research which is required in this area.

Implications of the review for practice and research
Methodologically rigorous studies are required to examine the effectiveness of different EMS systems.

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Other publications of related interest
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