Rapid response teams: a systematic review and meta-analysis
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CRD summary
This review concluded that rapid response team intervention appeared to reduce rates of cardiopulmonary arrest outside the intensive care unit, but that evidence to support their effectiveness in reducing mortality was lacking. This was a generally well-conducted review and the authors' conclusions appear to reflect the evidence, but the robustness of the results should be taken into consideration.

Authors' objectives
To assess the effectiveness of rapid response teams in reducing cardiopulmonary (cardiac) arrest and hospital mortality rates.

Searching
PubMed, EMBASE, Web of Knowledge, CINAHL and EBM Reviews (including Cochrane databases) were searched between January 1950 and November 2008 without language restrictions. Search terms were reported. Bibliographies of key articles and abstracts from the following conferences (between 2006 and 2008) were handsearched: American Heart Association, American College of Cardiology, American College of Chest Physicians and American College of Emergency Physicians.

Study selection
Randomised controlled trials (RCTs) and prospective active intervention studies that compared rapid response team intervention among hospital inpatients with a control group or period were eligible for inclusion. Eligible studies were required to report on the primary outcome of hospital-wide mortality or the secondary outcome of rates of non intensive care unit-treated cardiopulmonary arrest.

Included studies were mostly of adults (some were of children) in academic, community or mixed hospitals. Most studies included patients with do not resuscitate status. Rapid response team start dates ranged from 1996 to 2006. Most studies included a physician on the team. Rapid response team activation criteria were similar across studies, but the number of activations varied considerably between hospitals. Where reported, the control period ranged between four and 60 months, roll out period ranged between zero and 24 months and the rapid response team period ranged between four and 50 months.

Two reviewers independently selected studies for inclusion. Disagreements were resolved through discussion.

Assessment of study quality
The quality of the included studies was assessed according to whether they were adjusted for confounding (age, sex, ethnicity and case mix) between the control and intervention periods and for time trends that used either control groups or an interrupted time series design with at least three data points before and after intervention. Studies classed as high quality adjusted for both confounding and time trends, studies that adjusted only for confounding were classed as fair quality and studies that did not adjust for either were classed as low quality.

The authors did not state how many reviewers performed the validity assessment.

Data extraction
Two reviewers independently extracted data on hospital mortality and cardiac arrest event rates in control and intervention periods to calculate relative risks (RRs) and their 95% confidence intervals. Authors were contacted for further data where necessary.

The authors did not state how discrepancies were resolved.
Methods of synthesis
Relative risks were pooled using a random-effects model. Statistical heterogeneity was assessed using the $I^2$ statistic. Meta-regression was conducted to further investigate heterogeneity between studies. The cumulative influence of each study on the pooled estimate over calendar time was examined. Sensitivity analyses was performed by excluding each study in turn. Subgroup analyses were conducted for study population (children or adults), study quality, studies of patients by do not resuscitate status (studies that excluded do not resuscitate patients versus studies that included such patients) and frequency of rapid response team activation.

An additional evaluation examined the extent to which lower hospital mortality rates were attributable to reductions in cardiac arrest by the rapid response team intervention.

Publication bias was assessed using the Begg test.

Results of the review
Seventeen studies, with one reported as two separate studies (n=1,271,864 admissions: 580,776 control period and 691,088 intervention period) were included in the review. Two were RCTs, 12 before-and-after studies, two time series and two concurrent controls. Six studies were classed as high quality, two as fair and 10 as low quality.

Hospital mortality (15 studies): There was no significant difference in overall hospital mortality. There was evidence of significant statistical heterogeneity ($I^2=90.3\%$). Subgroup analyses indicated a significant reduction in hospital mortality in children (RR 0.79, 95% CI 0.63 to 0.98; four studies), but sensitivity analyses indicated that the pooled mortality estimate in children was not robust. There was no evidence of publication bias using the Begg test.

Cardiac arrest (16 studies): There was a significant overall reduction in the rate of cardiac arrest outside the intensive care unit (RR 0.65, 95% CI 0.55 to 0.77). There was evidence of significant statistical heterogeneity ($I^2=73.9\%$). Subgroup analyses reported a more modest reduction in cardiac arrest among high-quality studies of adult populations. Results from the sensitivity analyses were not reported. There was no evidence of publication bias.

The results of the cumulative influence of each study on the pooled mortality estimate in adults over calendar time showed that there was no association between lower hospital mortality and implementation of rapid response teams.

Authors' conclusions
Although rapid response team intervention appeared to reduce rates of cardiopulmonary arrest outside the intensive care unit, the evidence to support their effectiveness in reducing mortality was lacking.

CRD commentary
The review question was clear and was supported by appropriate inclusion criteria. A complex search of the literature was conducted without language restrictions, which reduced the potential for language bias. Unpublished studies such as conference proceedings were included in the search, which reduced the possibility that potentially relevant articles were missed; there was no evidence of publication bias. The authors undertook some form of validity assessment, but this was somewhat limited and the quality of most studies was low. Although the reviewers went some way to minimise reviewer error and bias by undertaking study selection and data extraction in duplicate, this did not appear to be the case for validity assessment. The sample sizes were substantial for the individual studies, which indicated sufficient power. Given the differences in the studies, pooling of the results may not have been appropriate. Given that there was evidence of significant statistical heterogeneity, the pooled estimates were of limited value. The authors acknowledged further limitations with the included studies, such as potential for participant selection bias and an overestimation of the effect of the rapid response team intervention on cardiac arrest. Sensitivity analyses indicated that mortality estimates were not robust in children. The review was generally well conducted and the authors' conclusions appear to reflect the evidence available, but the above limitations should be taken into consideration.

Implications of the review for practice and research
Practice: The authors stated that given the lack of robust evidence, health quality organisations may need to reconsider their promotion of rapid response teams.
Research: The authors stated that more rigorous and standardised studies were required for future research.

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