Early extubation after pediatric cardiac surgery: systematic review, meta-analysis, and evidence-based recommendations
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CRD summary
This well-conducted review concluded that early extubation appeared safe and was associated with reduction in length of intensive care unit and hospital stay, without adverse effects on mortality or morbidity, after paediatric heart surgery. However, available studies were poor, varied and not suitable to demonstrate a causal effect. These conclusions are likely to be reliable.

Authors' objectives
To investigate the safety and efficacy of early extubation after paediatric cardiac surgery.

Searching
MEDLINE, EMBASE, CINAHL, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials (CENTRAL), ACP Journal Club, and DARE were searched from inception (end date not specified) for studies of any language and publication status. Search terms were reported. Major cardiology, cardiac surgery, anaesthesia and critical care society abstracts from annual meetings were searched. Reference lists were handsearched.

Study selection
Studies of any design that included paediatric patients (younger than 18 years) undergoing any paediatric cardiac surgical procedure (with or without cardiopulmonary bypass) that applied an early extubation strategy (in the operating room or within six hours after surgery) were eligible for inclusion. The eligible comparator was a cohort of patients who were extubated more than six hours after surgery. Studies also had to report at least one of the primary outcomes of interest including early extubation failure (rate of re-intubation), early (in-hospital) mortality, intensive care unit and hospital length of stay and costs, and respiratory morbidity (presence of pulmonary infiltrate or atelectasis in the chest radiograph). Patients that required intubation prior to the day of surgery were excluded.

The included studies were conducted in the USA, Canada, the Netherlands and Israel; they were published from 1980 to 2009. The included patients had a variety of simple and complex congenital conditions. The anaesthetic protocols used varied; a range of induction and maintenance anaesthetics were used. Postoperative pain control used in the included studies was paracetamol and morphine, where reported. In most studies, early extubation was in the operating theatre.

Two reviewers selected papers for inclusion.

Assessment of study quality
Methodological quality was assessed by two reviewers using the criteria recommended by the US Preventative Services Task Force assessing randomisation, comparability of groups, reporting, loss to follow-up, intention-to-treat analysis, and whether the study was adequately powered.

Data extraction
Relative risks (RRs) for binary outcomes and mean difference (MD) for continuous outcomes and associated 95% confidence intervals (CIs) were calculated where possible.

The number of reviewers that extracted data was not reported.

Methods of synthesis
Where meta-analysis was possible relative risks or mean differences and 95% confidence intervals were pooled using a random-effects model. Heterogeneity was assessed using $X^2$ and quantified using $I^2$.
Results of the review

Twenty-three studies were included in the review. Nine were eligible for meta-analysis (n=2,014 patients; range 36 to 1,000). One was an RCT (n=100 patients), seven were retrospective case control studies (n=914 patients) and one was a retrospective cohort study (n=1,000 patients). All of the studies were considered poor quality; groups were not comparable at baseline or adequately powered (where reported).

Early extubation was associated with significantly improved in-hospital mortality rates compared with control (RR 0.1, 95% CI 0.01 to 0.84; n=1,233 patients), but this was associated with substantial heterogeneity (I^2=77%). There was no significant difference between early extubation and control groups for re-intubation rates, hospital costs, respiratory morbidity, intensive care unit length of stay and hospital stay.

The authors stated that none of the included studies (13 studies) showed any significant adverse effect of early extubation.

Authors' conclusions

Early extubation appeared safe and was associated with reduction in length of intensive care unit and hospital stay without adverse effects on mortality or morbidity. However, the available studies were poor, heterogeneous and not suitable to demonstrate a causal effect, so more research was needed.

CRD commentary

The research question was well-defined and supported by explicit inclusion criteria. The possibility of language and publication bias was minimised through a search of all languages and published plus unpublished studies. Two reviewers were involved in study selection and quality assessment, which reduced the possibility of reviewer error and bias, although such methods were not reported for data extraction.

Study quality was assessed using appropriate criteria and taken into consideration in the analysis. Heterogeneity was also assessed. The authors discussed the limited strength of the conclusions that could be drawn due to considerable heterogeneity and poor quality studies.

This review was generally well conducted and the authors' conclusions are likely to be reliable.

Implications of the review for practice and research

Practice: The authors stated that, although early extubation appeared safe, the available evidence was insufficient to recommend for or against the routine application of an early extubation strategy.

Research: The authors stated that good quality, large randomised controlled trials were warranted and further research should focus on the optimal perioperative, operative and pain management protocols.

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