Central venous catheter replacement strategies: a systematic review of the literature

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Authors' objectives
To evaluate the effect of guidewire exchange and new-site replacement strategies on the frequency of central venous catheter colonisation and infection, catheter-related bacteraemia, and mechanical complications in critically-ill patients. In addition, to compare scheduled catheter management with as-needed catheter management with reference to these outcomes.

Searching
The following sources were searched: MEDLINE from 1966 to July 1996 (search terms listed in the paper); the Science Citation Index (search dates unclear); Index Medicus from 1951 to 1995; the bibliographies of the retrieved papers; and the authors' own personal files. In addition, the proceedings of two relevant scientific meetings were handsearched, and the Cochrane Collaboration and people conducting primary research in the field were contacted. The first authors of each included study were contacted for help in identifying other relevant material. Both published and unpublished studies were sought.

Study selection
Study designs of evaluations included in the review
Randomised controlled trials (RCTs), including those using techniques to produce quasi-randomisation. Studies in which less than 50% of the eligible patients were randomised to catheter-exchange strategies were excluded.

Specific interventions included in the review
Central venous catheter management using either the guidewire exchange technique or new-site replacement, and management using scheduled versus as-needed replacement.

Participants included in the review
Critically-ill adult patients with central venous catheters were included.

Outcomes assessed in the review
The outcomes assessed were:
catheter colonisation, usually defined as growth of more than 15 colony-forming units in patients with negative blood cultures;
catheter exit-site infection, defined as the presence of erythema with induration, pus or tenderness at the catheter entry site and a positive catheter culture yielding more than 15 colony-forming units;
catheter-related bacteraemia, defined variously across the trials (details provided in the paper);
mechanical complications, including pneumothorax, arterial puncture, bleeding requiring transfusion, haemothorax, hydrothorax, venous thrombosis, cardiac arrhythmias, prolonged procedures, inability to thread the catheter, and incorrect catheter positioning.

How were decisions on the relevance of primary studies made?
Two reviewers independently examined the titles and abstracts of the identified citations. If either reviewer identified a study as being relevant, the full report was retrieved. Two independent reviewers applied the inclusion criteria to the full reports.

Assessment of study quality
Validity was assessed on the basis of the following: the method of randomisation; blinding of the caregiver and assessor; description of the outcome; whether there were post-randomisation exclusions; and whether intention to treat analysis was used. Two independent reviewers applied the criteria described. Agreement between the reviewers was assessed using a kappa-test.

Data extraction
Two independent reviewers extracted data on aspects of study population, intervention, outcome, and methodological quality. The authors of the primary studies were asked to check the accuracy of the extracted data and provide additional details where necessary.

Methods of synthesis
How were the studies combined?
A combined relative risk (RR) with associated 95% confidence intervals (CIs) was calculated using a random-effects model, using catheters as the unit of analysis. Guidewire exchange was compared with new-site placement matching the time intervals that the catheters were in place (3-day subgroups, 7 day subgroups, and as-needed subgroups were compared); different time intervals for catheter replacement were also compared. When p was greater than 0.05, differences in RR of greater than or equal to 20% were considered to represent a trend, whilst differences of less than 20% were considered to represent no difference.

How were differences between studies investigated?
Tests for heterogeneity were conducted using the method of Fleiss (see Other Publications of Related Interest). A sensitivity analysis was carried out to compare catheter replacement techniques in patients who had suspected infection at randomisation with those who did not. A further analysis was conducted according to the definition of catheter-related infection. This analysis included only trials of high methodological quality (i.e. it excluded those where quasi-randomisation was used or if more than 25% of the patients were excluded after randomisation), which used a strict definition of catheter-related infection (i.e. bacteriological confirmation by catheter tip and peripheral blood cultures positive for the same organism, or at least a 4-fold increase in bacterial growth from catheter cultures versus peripheral blood cultures).

Results of the review
Twelve RCTs (918 patients and at least 1,913 catheters) were included.

Infection risk of guidewire exchange versus new-site replacement: guidewire exchange was associated with a trend towards a higher rate of catheter colonisation (8 trials; RR 1.26, 95% CI: 0.87, 1.84), regardless of whether patients had a suspected infection. The test for heterogeneity was non significant. Guidewire exchange was also associated with a trend towards a higher rate of catheter exit-site infection (4 trials; RR 1.52, 95% CI: 0.34, 6.73) and catheter-related bacteraemia (8 trials; RR 1.72, 95% CI: 0.89, 3.33).

Mechanical complications: guidewire exchange was associated with fewer mechanical complications compared with new-site replacement (9 trials; RR 0.48, 95% CI: 0.12, 1.91).

Prophylactic catheter replacement (guidewire and new-site): exchanging catheters over guidewires or at new sites every 3 days was not beneficial in reducing infections, compared with catheter replacement every 7 days or as-needed (4 trials). The RR was 0.89 (95% CI: 0.41, 1.91) for catheter-related bacteraemia and 0.87 (95% CI: 0.65, 1.16) for catheter colonisation.

Authors' conclusions
Guidewire exchange of central venous catheters may be associated with a greater risk of catheter-related infection, but fewer mechanical complications than new-site replacement. If guidewire exchange is used, meticulous aseptic technique is necessary. The data did not support prophylactic exchange of catheters using either technique.
CRD commentary
Overall, this appeared to be a well-conducted systematic review. The research questions, selection criteria, quality assessment of primary studies, and study details were all clearly presented with adequate details. The search strategy was thorough, but could have been enhanced by including some other electronic databases such as EMBASE. It is unclear whether only English language studies were considered eligible; if so, then the possibility of language bias cannot be excluded. Although the authors attempted to locate unpublished data, there did not appear to be any included in the review, therefore, publication bias also remains a possibility. The methods used for pooling the data were appropriate. A discrepancy was noted between the text and figure for the summary RR estimate for mechanical complications.

The authors’ conclusions appear to reflect the evidence arising from this review, and they are right to suggest that further research is required in this field.

Implications of the review for practice and research
The authors state that more randomised trials are needed to affirm or refute the trends identified in this meta-analysis. More studies on scheduled versus as-needed replacement strategies, using both guidewire exchange and new-site replacement of central venous catheters, are warranted.

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