Effectiveness of different central venous catheters for catheter-related infections: a network meta-analysis


CRD summary
This review compared the effectiveness of various catheters for preventing catheter-related infection and whether some led to fewer infections. The hesitant conclusion was that rifampicin-based impregnated catheters seemed to be better for prevention of catheter-related infections compared with other catheters. Overall, poor study quality and clinical heterogeneity mean that the conclusion should be interpreted with caution.

Authors' objectives
To compare the effectiveness of various catheters for preventing catheter-related infection and evaluate whether specific catheters were superior to others for reducing catheter-related infections.

Searching
The reviewers searched PubMed, EMBASE, Web of Science and Cochrane Central Register of Controlled Trials (CENTRAL) for relevant studies. Search terms and some date restrictions were reported. No language restrictions were reported. Bibliographies of previous systematic reviews, meta-analyses and retrieved articles were searched for relevant studies.

Study selection
Eligible studies were randomised controlled trials that compared various commercially available central venous catheters and provided definitions and outcomes of catheter colonisation and/or catheter-related blood stream infections.

Direct comparisons between regimens included comparisons of standard care with benzalkonium chloride, silver iontophoretic, minocycline rifampicin, miconazole rifampicin, heparin-bonded, silver impregnated, silver alloy coated and chlorhexidine and silver sulfadiazine catheters blue plus. Other direct comparisons were between chlorhexidine and silver sulfadiazine and minocycline rifampicin, silver alloy coated and heparin bonded. Other comparisons included benzalkonium chloride versus silver iontophoretic and silver iontophoretic versus minocycline-rifampicin. Mean central venous catheter insertion ranged from four to 66 days. Central venous catheters were single to triple lumen. Most studies were in middle-aged adults; mean/median ages and ranges were reported for most studies. Study locations included USA, Germany, Australia, UK, Belgium, Sweden, the Netherlands, Spain, Italy, France, Turkey, Tunisia, Brazil, Taiwan, Romania and South Africa. Most patients were within intensive care units.

Two reviewers independently selected studies for inclusion. It was not clear how disagreements were resolved.

Assessment of study quality
Two reviewers independently assessed study quality according to criteria of sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting and other sources of bias. Disagreements were resolved by consensus.

Data extraction
Two reviewers independently extracted data on odds ratios (ORs) with 95% confidence intervals (CIs) or calculated odds ratios and 95% CIs from incidence rates. Disagreements were resolved by consensus.

Methods of synthesis
A network meta-analysis was performed to estimate odds ratios with 95% CIs for all pairs of treatments in the models. Bayesian Markov Chain Monte Carlo simulation network analysis was used to combine direct and indirect comparisons. Random-effects and fixed-effect models were conducted and selected using the deviance information criterion. Between-study heterogeneity was estimated from the median between-study variance (τ^2) and considered low if less
than 0.04 and high if 0.30 or more. Sensitivity analyses were conducted by omitting specific trials and by including trial characteristics as covariates.

**Results of the review**

Forty-eight studies (11,525 patients and 12,828 central venous catheters) were included in the review. Study quality ranged from 2 to 5 points and overall was rated as poor; 20 studies were considered to be of high quality.

**Catheter colonisation:** Based on a network meta-analysis of 43 studies (n=11,280 central venous catheters), the catheters estimated to be statistically significantly better than standard catheters in terms of reduced rates of catheter colonisation were silver iontophoretic (OR 0.58, 95% CI 0.33 to 0.95), CHSS (chlorhexidine and silver sulfadiazine) (OR 0.49, 95% CI 0.36 to 0.64), CHSS+ (OR 0.37, 95% CI 0.17 to 0.69), minocycline rifampicin (OR 0.28, 95% CI 0.17 to 0.43) and miconazole rifampicin (OR 0.11, 95% CI 0.02 to 0.33).

Catheter types that were not statistically significantly different from standard catheters were heparin-bonded, silver alloy coated, silver impregnated and benzalkonium chloride. Miconazole-rifampicin was superior to heparin-bonded catheters and benzalkonium chloride. Miconazole-rifampicin, minocycline-rifampicin, CHSS and CHSS+ catheters were superior to silver alloy-coated catheters. Miconazole-rifampicin and minocycline-rifampicin catheters were superior to silver-impregnated catheters, silver iontophoretic catheters and CHSS catheters. Moderate statistical heterogeneity ($\tau^2=0.25$) was identified in the network meta-analysis.

**Catheter-related bloodstream infections:** Based on a network meta-analysis of 45 studies (n=12,085), the catheters estimated to be statistically significantly better than standard catheters in terms of reduced rates of catheter-related blood infections were heparin bonded (OR 0.20, 95% CI 0.06 to 0.44), silver iontophoretic (OR 0.41, 95% CI 0.13 to 0.91), CHSS (OR 0.68, 95% CI 0.44 to 0.96) and minocycline rifampicin (OR 0.18, 95% CI 0.08 to 0.34). Catheters that were not statistically significantly different from standard catheters for this outcome were silver alloy-coated, silver impregnated, CHSS+ and benzalkonium chloride. No non-standard catheter was significantly better than any other non-standard catheter. Moderate statistical heterogeneity ($\tau^2=0.23$) was identified in the network meta-analysis.

Various sensitivity analyses were performed for both outcomes. Trial quality, whether the population were intensive care units patients, whether there were at least 100 central venous catheters in the trial and whether single patients contributed more than one central venous catheter event were all covariates that affected the pooled estimates.

**Authors' conclusions**

The network meta-analysis should be interpreted cautiously due to the small number of studies, but rifampicin-based impregnated catheters seemed to be better for prevention of catheter-related infections when compared with other catheters.

**CRD commentary**

The review question was clear. The study selection was clearly stated, although broad in terms of population. More than one author was involved in study selection, which reduced risks of reviewer error and bias. The search was thorough in terms of numbers of databases searched. Efforts to identify unpublished studies were more limited. Included study details were detailed enough to indicate that there was significant clinical heterogeneity in terms of population. A standard instrument was used to assess study quality and this stage of the process was conducted in duplicate, which reduced risks of reviewer error and bias; most included studies were judged to be of poor quality, which raised the risk of bias. The extraction was conducted in duplicate. The method of synthesis allowed for indirect comparisons between treatments and made good use of the available evidence, but uncertainties surrounding network analyses needed to be taken into consideration. Many subgroup analyses were performed to assess the effect of confounders on the results. The results were clearly and thoroughly reported. Sensitivity analyses suggested that the results may have been affected by clinical population heterogeneity and potentially multiple counting (one individual counting more than one observation to results).

Overall, poor study quality and clinical heterogeneity mean that the conclusion should be interpreted with caution.
**Implications of the review for practice and research**

**Research**: The authors stated that continued studies were required to clarify further the possibility of resistance development, especially in the context of long-term catheterisation.

**Practice**: The authors did not state any implications for practice.

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