Prevention of nosocomial bloodstream infections: effectiveness of antimicrobial-impregnated and heparin-bonded central venous catheters

Marin M G, Lee J C, Skurnick J H

Authors' objectives
To examine the effectiveness of antimicrobial-impregnated and heparin-bonded catheters, relative to standard central venous catheters, in lessening catheter-related blood-stream infection.

Searching
Searches were conducted of the following databases: MEDLINE from 1966 to 1999; CINAHL from 1982 to 1999; Current Contents(Clinical Medicine) and Current Contents(Life Sciences) from 1988 to 1999; and HealthSTAR from 1991 to 1999. Combinations of the following textwords and subject headings were used: 'venous catheter', 'catheterization, central venous', 'antiseptic', 'sulphadiazine', 'chlorhexidine', 'germicidal', 'germicide', 'monocycline', 'rifampin', 'heparin' and 'anti-infective agents'.

Additional studies were located by examining the reference lists of identified studies, and by contacting the authors of the identified studies and experts in the field.

Study selection
Study designs of evaluations included in the review
All of the included studies were randomised controlled trials (RCTs).

Specific interventions included in the review
Comparisons of antimicrobial-impregnated or heparin-bonded catheters with standard central venous catheters were eligible. Most of the included studies used experimental catheters impregnated with silver sulfadiazine and chlorhexidine (SS-C). Two studies used either heparin-bonded catheters, or catheters coated with minocycline and rifampin. Where reported, the duration of catheterisation ranged from 1 to 51 days (2 studies), and the mean duration (intervention group) ranged from 6.0 to 12.9 (6 studies).

Participants included in the review
Adults aged at least 17 years who had undergone intravascular catheterisation were included. The included studies were conducted in the following settings: cardiac surgery; total parenteral nutritional support; general and cancer hospital; combined medical and surgical intensive care unit; transplant unit; and haematological malignancy.

Outcomes assessed in the review
Studies that provided original data on the assessment of catheter-related blood stream infections, or the cost-effectiveness of using eligible catheters, were eligible. Catheter infections and catheter-related bloodstream infections were defined with degrees of varying rigour. In catheter infections, an infecting microorganism was cultured from the catheter tip, intradermal segment, hub, infusate, and/or blood drawn from the catheter. In catheter-related bloodstream infections, the studies required isolation of a similar organism from the peripheral blood and the catheter. The similarity of organisms was defined, where specified, as having a similar antibiogram or being similar by DNA molecular typing. Clinical evidence of sepsis was required in some cases.

How were decisions on the relevance of primary studies made?
The titles and/or abstracts of the identified studies were reviewed. The authors do not state how many of the reviewers performed the selection.

Assessment of study quality
The studies were restricted to RCTs, although no formal validity assessment was undertaken.
Data extraction
The authors do not state how the data were extracted for the review, or how many of the reviewers performed the data extraction.

Data were extracted for the following categories: authors, title, reference source, and publication date; type of control; study setting; type of experimental catheter used; catheter-specific complications; the total number of patients and catheters; outcomes; the organisms infecting catheters, and those cultured in the bloodstream; and duration of catheterisation.

Methods of synthesis
How were the studies combined?
The pooled odds ratio (OR) and 95% confidence interval (CI) were calculated using the Peto method (see Other Publications of Related Interest no.1). A pooled rate difference of infection between the experimental and control interventions was calculated using a general variance method (see Other Publications of Related Interest no.1).

How were differences between studies investigated?
The chi-squared test was used to assess the statistical homogeneity of the ORs. The homogeneity of differences in the rates was assessed using a test described by DerSimonian and Laird test (see Other Publications of Related Interest no.2).

A subgroup analysis was conducted by restricting the analysis to studies using SS-C catheters.

Results of the review
Eleven RCTs involving at least 2,060 patients (2,957 catheterisations) were included. The sample size for one study was not reported.

Antimicrobial-impregnated and heparin-bonded central venous catheters significantly reduced catheter-related bloodstream infections; the pooled OR was 0.58 (95% CI: 0.40, 0.84). Evidence of significant heterogeneity was found (p<0.025). Restricting the analysis to the 9 studies using SS-C catheters eliminated heterogeneity (p>0.01), and gave results that did not differ significantly from the whole group; the approximate pooled OR, as estimated from the forest plot, was 0.68 (95% CI: 0.48, 0.9). There was no longer evidence of heterogeneity (p>0.1).

The overall reduction in catheter-related bloodstream infection with antimicrobial-impregnated and heparin-bonded central venous catheters was 2.32% (95% CI: 1.04, 3.61). No evidence of heterogeneity was found (p=0.18).

There was no evidence to suggest that the experimental catheters were associated with the development of more virulent pathogenic organisms. The antibiotic-resistance patterns of the isolated microorganisms were not published.

Cost information
The additional cost of the experimental catheter was estimated, based on charges at the University Hospital (Newark, NJ, USA). Assuming that the use of impregnated catheters decreases catheter-related bloodstream infections by 2.3 per 100 catheterisations, then the cost of preventing each bloodstream infection is $1,552.

Authors' conclusions
Antimicrobial-impregnated and heparin-bonded central venous catheters significantly reduced catheter-related bloodstream infections. The modest additional cost for the use of these catheters, relative to the considerable cost of treating a single bloodstream infection, makes their use cost-effective.

CRD commentary
The aims of the review were stated, and the inclusion criteria were defined in terms of the study design, participants,
interventions and outcomes. Several relevant databases were searched and attempts were made to locate unpublished material. Full details were given of the search strategy, although it was not reported whether any language restrictions were applied. Studies were restricted to randomised controlled studies, although no formal validity assessment was undertaken.

The tables presented in the review contained adequate information on the included primary studies. However, there was a lack of information on any blinding of assessments. The data were pooled in a meta-analysis and statistical homogeneity was assessed. Where there was evidence of heterogeneity, a potential source was explored. The evidence presented supports the authors' conclusions, although the apparent lack of study blinding and the limited details of the review methodology, must be borne in mind.

Implications of the review for practice and research
Practice: The authors state that the use of antimicrobial-impregnated and heparin-bonded catheters seems justified in a broad range of clinical settings.

Research: The authors did not report any implications for further research.

Bibliographic details

PubMedID
11008998

Other publications of related interest

Indexing Status
Subject indexing assigned by NLM

MeSH
Adult; Anti-Bacterial Agents /administration & dosage; Catheterization, Central Venous /instrumentation; Coated Materials, Biocompatible; Cross Infection /prevention & control; Heparin /administration & dosage; Humans; Randomized Controlled Trials as Topic; Sepsis /prevention & control

AccessionNumber
12000001879

Date bibliographic record published
30/06/2002

Date abstract record published
30/06/2002

Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.