Cost-effectiveness of antiseptic-impregnated central venous catheters for the prevention of catheter-related bloodstream infection

Veenstra D L, Saint S, Sullivan S D

Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
Use of antiseptic-impregnated central venous catheters employing an antiseptic combination of chlorhexidine and silver sulfadiazine for the prevention of catheter-related bloodstream infection (CR-BSI) in patients at high risk for catheter-related infections needing the short term use (2 to 10 days) of multilumen central venous catheters.

Type of intervention
Secondary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
Hospitalized patients at high risk for catheter-related infections (such as patients in ICUs, immunosuppressed patients, and patients receiving total parenteral nutrition) needing the short term use (2 to 10 days) of multilumen central venous catheters.

Setting
Hospital. The economic study was carried out in the USA.

Dates to which data relate
Effectiveness data were based on the literature published between 1989 and 1999. Resource use data (excess ICU stay for patients with CR-BSI who survived) was based on a study published in 1994 using 1988-1990 data. The fiscal year was 1998.

Source of effectiveness data
Effectiveness data were derived from a review of the literature.

Modelling
A decision analytic model was constructed to estimate the costs and effects associated with each health technology employed in the study.

Outcomes assessed in the review
The following outcomes were assessed: the probability of CR-BSI for the standard catheter (95% CIs were reported), the summary risk ratio (RR) for CR-BSI, the probability of catheter colonization for the standard catheter, the summary risk ratio (RR) for catheter colonization, the probability of death attributable to CR-BSI, the probability of
hypersensitivity reaction, the probability of death from hypersensitivity reaction, and probability of local infection if colonization.

**Study designs and other criteria for inclusion in the review**
Randomized controlled trials, a matched case-control study, and other reports were included. The cohort selected for study was the population of hospitalized patients at high risk of catheter-related infections. The time frame chosen for the study was the duration of hospitalization (2 to 10 days).

**Sources searched to identify primary studies**
The clinical studies used in the analysis were obtained from a separate met-analysis. See Veenstra et al in "Other Publications of Related Interest" below.

**Criteria used to ensure the validity of primary studies**
Details are contained in a separate meta-analysis. See Veenstra et al in "Other Publications of Related Interest" below.

**Methods used to judge relevance and validity, and for extracting data**
Details are contained in a separate meta-analysis. See Veenstra et al in "Other Publications of Related Interest" below.

**Number of primary studies included**
A meta-analysis of 13 randomized studies, and nine other studies were used.

**Methods of combining primary studies**
Primary studies were combined using meta-analysis and narrative method. The summary RR for CR-BSI was calculated using Mantel-Haenszel methods. The method used to estimate the probability of CR-BSI with standard catheter was to statistically pool the proportion of standard catheters associated with CR-BSI. In the calculation of the summary RR for catheter colonization, which was based on a subset of randomized trials originally included in the review, only the cases of catheter colonization without associated blood-stream infection were considered.

**Investigation of differences between primary studies**
The heterogeneity of treatment effects among the randomized trials used in the calculation of summary RR for CR-BSI was tested, but proved not to be significant, (p=0.80). The subset of trials used in the calculation of the summary RR for catheter colonization showed no statistical evidence of heterogeneity (p=0.10) or publication bias.

**Results of the review**
The probability of CR-BSI for the standard catheter was 5.2% (95% CI: 3.9 - 6.5); the summary risk ratio (RR) for CR-BSI was 0.582 (95% CI: 0.398 - 0.851); the probability of catheter colonization for the standard catheter was 24.7% (95% CI: 22.0 - 27.5); the summary RR for catheter colonization was 0.61 (95% CI: 0.51 - 0.73); the probability of death attributable to CR-BSI was 15% (95% CI: 5.0 - 25.0); the probability of hypersensitivity reaction was 0.0111% (95% CI: 0.0056 - 0.0222); the probability of death from hypersensitivity reaction was 7.7% (95% CI: 3.9 - 15.4); and the probability of local infection if colonization was 50% (95% CI: 25 - 75).

**Measure of benefits used in the economic analysis**
Death avoided (the difference in incidence of death due to catheter-related bloodstream infection or hypersensitivity between two catheter types) was the main benefit measure. The differences in incidence of catheter-related bloodstream infection and in incidence of local infections were among the other benefit measures reported in the study.
Direct costs
Costs were not required to be discounted due to the short time horizon adopted for the study. Quantities of excess ICU stay and ward days were reported separately from the costs. Cost items were reported separately. The cost analysis covered the additional cost of antiseptic catheter, costs of CR-BSI (excess ICU stay and ward days), hypersensitivity reaction, and cost of managing local infection. The perspective adopted in the cost analysis was that of the health care payer. Resource use data (excess ICU stay for patients with CR-BSI who survived) was based on a study published in 1994 using 1988-1990 data. The main source of cost data was the University of Washington Medical Center. A cost-to-charge ratio of 0.63 was used to translate the charge data to cost data. The cost analysis did not cover the procedural costs or professional fees.

Statistical analysis of costs
In the Monte Carlo simulation performed for multivariate sensitivity analysis, costs were modelled using gamma distributions.

Indirect Costs
Not included.

Currency
US dollars ($).

Sensitivity analysis
A set of one-way sensitivity analyses was performed on clinical probabilities and costs. Threshold analyses were conducted to identify the cut-off values of sensitive parameters of the model. Analysis of extremes was conducted by assessing the impact of the worst-case scenario on the cost-effectiveness of the alternatives. A set of multivariate probabilistic sensitivity analyses was performed using Monte Carlo simulation (logistic normal distributions were employed for the clinical probabilities and gamma distributions for the costs).

Estimated benefits used in the economic analysis
The incidence of death due to catheter-related bloodstream infection or hypersensitivity was 0.45% for the antiseptic-impregnated catheter versus 0.78% for the standard catheter, leading to a difference of -0.33% (range based on multivariate sensitivity analysis: -0.78 to 0.09). The incidence of catheter-related bloodstream infection was 3% for antiseptic-impregnated catheter versus 5.2% for the standard catheter, leading to a difference of -2.2% (range: -3.4 to 1.2). The incidence of local infections was 7.5% and 12.4%, respectively.

Cost results
The direct medical cost was $336 for the antiseptic-impregnated catheter versus $532 for the standard catheter, leading to a difference of -$196 (range based on multivariate sensitivity analysis, -$391 to $68).

Synthesis of costs and benefits
Costs and benefits were not combined since the use of the antiseptic-impregnated catheter was the dominant strategy. The set of one-way and multivariate sensitivity analyses established the robustness of the results to a wide range of reasonable change in parameters of the model.

Authors’ conclusions
The authors’ analyses suggest that use of chlorhexidine-silver sulfadiazine-impregnated central venous catheters in patients at high risk for catheter-related infections reduces the incidence of CR-BSI and death and provides significant saving in costs. Use of these catheters should be considered as part of a comprehensive nosocomial infection control
CRD COMMENTARY - Selection of comparators
The reason for the choice of the comparator is clear as it was the standard care in the authors’ setting.

Validity of estimate of measure of benefit
The estimates of benefit are likely to be internally valid mainly due to the use of randomized trials as the main source of clinical probabilities used in the model. The analysis was based on a systematic, peer-reviewed literature search, details of which were published in another paper (see Veenstra et al in "Other Publications of Related Interest” below).

Validity of estimate of costs
Quantities of resources were not fully reported separately from the costs. However, adequate details of methods of cost estimation were given. It was assessed that the limitations imposed on the study by adopting a short time frame and a payer’s viewpoint may have resulted in underestimation of the full cost savings potentially attainable by the use of the impregnated central venous catheters in the context in question. Some elements of costs were not included in the cost analysis.

Other issues
The authors’ conclusions are fully justified particularly given the extensive sensitivity analyses performed to tackle the uncertainties surrounding the variables of the model. The results of the study were deemed not to be generalisable to all patients requiring a central venous catheter (other than those at high risk of catheter-related infection). Appropriate comparisons were made with other studies. Results were not presented selectively.

Implications of the study
The authors suggest that:

(1) Clinical trials confirming the results are needed but may be expensive.

(2) More studies are required to "identify more clearly high-risk patients and the appropriate duration of catheterization for antiseptic-impregnated catheters."

(3) ”The attributable cost and mortality of CB-BSI have not been adequately studied, and a well-designed case-control study that matches patients for length of catheterization in addition to parameters such as disease severity is required.”

(4) The use of antiseptic-impregnated catheters should be monitored for the "potentially serious complication" of bacterial resistance "that could offset the benefits of their use in the long-run."

Source of funding
Dr Veenstra supported by a Roche postdoctoral fellowship, Dr Saint was a Robert Wood Johnson Clinical Scholar at the time of the study and Dr Sullivan was supported by grants HS/HL08368-01A1 and HS07834- 0351 from the National Institutes of Health.

Bibliographic details

PubMedID
Original Paper URL

Other publications of related interest
Saint S, Veenstra D L, Lipsky B A. The clinical and economic consequences of nosocomial central venous catheter-related infection: are antimicrobial catheters useful? Infection Control and Hospital Epidemiology 2000;21:375-380


Indexing Status
Subject indexing assigned by NLM

MeSH
Anti-Infective Agents, Local /administration & dosage /economics; Catheterization, Central Venous /adverse effects /economics /instrumentation; Cost-Benefit Analysis; Decision Trees; Equipment Contamination; Humans; Outcome Assessment (Health Care); Probability; Sensitivity and Specificity; Sepsis /economics /epidemiology /etiology /prevention & control; United States

AccessionNumber
21999008237

Date bibliographic record published
31/03/2000

Date abstract record published
31/03/2000