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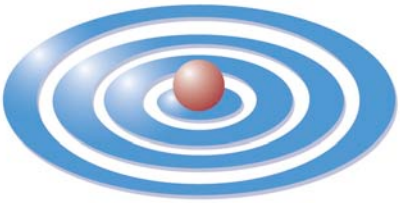

THE JOANNA BRIGGS INSTITUTE

Management of Peripheral Intravascular Devices

Technical report

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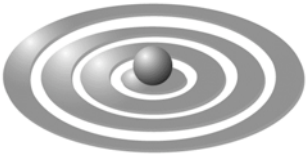

THE JOANNA BRIGGS INSTITUTE

JBI Best Practice Technical Reports

Joanna Briggs Institute Evidence Based Publications

The Joanna Briggs Institute is involved in the development and dissemination of a number of publications that inform health professionals about clinical practice and specifically what constitutes best practice in health care. These serials include the *International Journal of Evidence Based Healthcare* (formerly JBI Reports) published by Blackwell Publishing and available online at http://www.blackwell-synergy.com. Systematic reviews conducted by Collaborating Centres of the Joanna Briggs Institute are published in the *International Journal of Evidence Based Healthcare*. These systematic review reports are further abstracted and published by Blackwell Publishing as the series *Best Practice* Information Sheets for Health Professionals. All *Best Practice* Information Sheets are derived from systematic reviews of health care research literature either conducted by the Joanna Briggs Institute Collaborating Centres or in some cases by an external source.

Aims and scope of the Technical Report

The conduct of systematic reviews and the development of *Best Practice* Information Sheets involve rigorous, standardised methods to ensure that all information provided to health professionals is of the highest standard and constitutes best practice. The conduct of a systematic review and development of the corresponding *Best Practice* issue are two parts of a staged process. All aspects of the conduct of the systematic review and the development of the accompanying *Best Practice* issue are documented so that these methods may be scrutinised. The processes involved in conducting Joanna Briggs Institute systematic reviews, including review methods are documented within the systematic review report. The format of *Best Practice* precludes it from including detailed information regarding the abstraction of evidence and development of recommendations embodied in the publication. For this reason *JBI Best Practice Technical Reports* are provided as a complementary publication to document all aspects of the development of *Best Practice Information Sheets*. In determining the quality of the Joanna Briggs Institute *Best Practice Information Sheets* the information provided in the Technical Report and the Systematic Review Report should also be considered.

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Management of peripheral intravascular devices

Technical report

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Introduction

The aim of Joanna Briggs Institute evidence publications is to provide the best available evidence relating to clinical questions that are important to health professionals and consumers. Although the publications relate to the same clinical question/s and are therefore complementary they serve different purposes and so are of a different scope and format. The *Best Practice* Information Sheets are targeted to base level health professionals and are restricted to a six-page format, recognising the time constraints on today's clinicians. This prevents details of the development process being presented in the *Best Practice* Information Sheets. The *Best Practice* Information Sheet Technical Report provides this detail to allow scrutiny of the development process. The development of these publications is essentially a stepped process involving first the identification and synthesis of the evidence (Systematic Review) and then the abstraction of the evidence and development of recommendations for practice (*Best Practice* Information Sheets). In examining the methods and processes that ultimately produce practice recommendations the reader should consider the information available in the both the Systematic Review Report and the *Best Practice* Information Sheet Technical Report for a given information sheet.
This technical report details the development process for the following *Best Practice* Information sheet.

Joanna Briggs Institute (2008). Management of peripheral intravascular devices. *Best Practice Evidence Based Information Sheets for Health Professionals*, 12(5), 1-4.

Best Practice Information Sheets development methods

All Joanna Briggs *Best Practice* Information Sheets are developed by staff of the Joanna Briggs Institute in collaboration with staff from one of the Joanna Briggs Collaborating Centres with the assistance of an advisory panel of clinicians and other experts.

Acknowledgements

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Identification and synthesis of the evidence

All *Best Practice* Information Sheets are derived from systematic reviews of the best available evidence. This particular information sheet is based on two systematic reviews, two guidelines and one economic evaluation.

Gillies D, O'Riordan L, Wallen M, Morrison A, Rankin K, Nagy S. Optimal timing for intravenous administration set replacement (Review). *Cochrane Database of Systematic Reviews*. 2005, Issue 4.

Idvall, E, Gunningberg L. Evidence for elective replacement of peripheral intravenous catheter to prevent thrombophlebitis: a systematic review. *Journal of Advanced Nursing*. 2006; 55(6):715-722.

Guidelines for the Prevention of Intravascular Catheter-Related Infections. Centres for Disease Control Recommendations and Reports, August 9, 2002.

Pratt RJ, Pellowe CM, Wilson JA, Loveday HP, Harper PJ, Jones SRLJ, McDougall C, Wilcox MH. Epic2: National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England. *The Journal of Hospital Infection*. 2007; 65S:S1-S64.

Halton K, Graves N. Economic Evaluation and Catheter-related Bloodstream Infections. *Emerging Infectious Diseases*. 2007; 13(6).

Executive summary

Background

Intravenous devices are an important and common aspect of hospital practice for the administration of medications, nutrients, fluid, blood products and to monitor a person's haemodynamic status. While intravenous therapy is an essential part of contemporary hospital care, using an intravascular device is linked to hospital-related bloodstream infection (BSI), which in turn is associated with an increase in mortality. The routine replacement of intravenous administration sets has been suggested as preventing infectious complications of intravenous therapy. Furthermore, reducing the frequency of changing intravenous administration sets has important cost implications. If reducing the frequency of changing intravenous administration sets does not increase infection rates, a change in practice could result in considerable cost savings. The type of intravenous device, type of intravenous fluid and type of person may all affect the incidence of intravenous device related BSI. It may be necessary to change administration sets more frequently in people with a central catheter compared to people with a peripheral catheter. The frequency of changing administration sets may need to be increased in at-risk populations. The risk of colonization, and therefore BSI, may also increase if the infusate administered supports proliferation of contaminating organisms.

The administration of parenteral nutrition has been associated with an increased risk of catheter-related infection. Furthermore, as lipid emulsion is particularly suited to the growth of a wide range of micro-organisms it is suggested that sets used to administer lipids, either alone or in combination with parenteral nutrition, should be changed more often than

administration sets used for non-lipid solutions. While peripheral venous catheters (PICs) are rarely associated with BSIs they are commonly linked with phlebitis, a condition that is mainly a physiochemical or mechanical phenomenon rather than infectious. Contracting phlebitis is influenced by several factors: type of catheter material; catheter size; type of infusate; and patient's own risk. When phlebitis occurs the risk of developing a local catheter-related infection may rise.

To improve patient outcomes and reduce healthcare costs, sound management practices of peripheral intravenous devices should be implemented. A multidisciplinary approach is preferred involving: a designated team of IV therapy nurses who maintain and monitor intravascular catheters; healthcare managers who allocate resources; and patients who can assist in the care of their catheters.

Objectives

The objectives of the four systematic reviews included in this information sheet were as follows.

Gillies et al. (2005) set out to identify the optimal interval for the routine replacement of intravenous administration sets when infusate or parenteral nutrition (lipid and non-lipid) solutions are administered to people in hospital via central or peripheral venous catheters. Specific objectives were to:

- Determine the optimal time interval for routine replacement of intravenous administration sets when an infusate or parenteral nutrition (lipid and non-lipid containing solutions) is administered to people in hospital via a central or peripheral catheter.
- Conduct a subgroup analysis for intravenous fluids administered via central versus peripheral catheters.
- Conduct a subgroup analysis of the data for parenteral nutrition (lipid and non-lipid containing solutions) and infusates
- Conduct a subgroup analysis of the data for adults and children.

Idvall and Gunningberg (2006) aim to review the scientific evidence for elective replacement of peripheral intravenous catheters in adults in the absence of any clinical complications, in order to reduce the incidence and severity of thrombophlebitis.

Centres for Disease Control (2002) aim to provide healthcare practitioners with background and specific clinical recommendations that reduce the incidence of intravascular catheter-related bloodstream infections (CR-BSI). These guidelines have been developed for healthcare personnel who insert catheters and those responsible for monitoring infections in hospital outpatient, and home healthcare settings.

Pratt et al. (2007) have as their objective a description of the precautions healthcare workers should take in the following areas:

- Standard principles for preventing HCAI, including hospital environmental hygiene and hand hygiene;
- Using personal protective equipment
- Safe use and disposal of sharps; and
- Preventing infections linked to the use of short-term indwelling urethral catheters; and
- Preventing infections associated with central and peripheral catheters.

Halton and Graves (2007) aim to summarise the existing literature on model-based economic evaluation of interventions to prevent CR-BSI and then critique this literature, focusing on two issues: firstly, the usefulness of evaluations in terms of how the research questions and findings align with the information needed to make good decisions; and secondly, the quality of the evaluations, specifically regarding the quality of the model structure, source of parameter data and its incorporation into the model, and the techniques of the model.

Search strategy

Gillies et al (2005) searched the Cochrane Central Register of Controlled Trials (CENTRAL, in Cochrane Library, Issue 1, 2004), MEDLINE, EMBASE and CINAHL from their inception to February, 2004. The reference lists of identified trials and bibliographies of published reviews were also searched and researchers in the field were contacted. There was no language restriction in the search strategy.

Idvall and Gunningberg (2002) used a keyword search strategy for Ovid MEDLINE (1966-2005, week 4) and CINAHL (1982, 2005, week 5). The authors also handsearched the reference lists of studies.

Centres for Disease Control (2002) – while there is an extensive reference list of trials, audits and reviews at the back of this document, the search strategy process is not documented.

Pratt et al (2007) searched for citations published during the period 1 January 1999-31 August 2005, using a two-phase process. Stage 1 involved looking for systematic reviews and guidelines in Cochrane Library, National Guideline Clearinghouse, National Electronic Library for Health, and National Institute for Health and Clinical Excellence (NICE). Stage 2 constituted a systematic search for additional economic evidence in MEDLINE, CINAHL, EMBASE and Cochrane Library.

Halton and Graves (2007) searched for data published between 1990 and November, 2005 in MEDLINE, CINAHL, Biologic Abstracts, Centre for Reviews and Dissemination, Academic Search Elite and EconLit with MeSH headings and keywords

Selection criteria
Gillies et al (2005) looked at all randomised or quasi-randomised controlled trials addressing the frequency of replacing intravenous administration sets when parenteral nutrition (lipid and non-lipid containing solutions) or infusions (excluding blood) being administered to people in hospital via a central or peripheral catheter.

Idvall and Gunningberg (2002) included randomised controlled trials of elective replacement of peripheral intravenous catheters in adults. Three reviewers assessed the data found according to predetermined criteria. Quality and relevance were rated as high, medium or low, in accordance with the rating scale used by SBU.

Centres for Disease Control (2002) included studies that:

- Educated and trained healthcare providers who insert and maintain catheters
- Used maximal sterile barrier precautions during central venous catheter insertion
- Used a 2% chlorhexdine preparation for skin antisepsis
- Avoid routine replacement of central venous catheters to prevent infection
- Identify performance indicators that can be used locally by healthcare institutions or organizations to monitor their success in implementing evidence-based recommendations

Pratt et al (2007) based their selection criteria on English language, multiple systematic reviews of experiemental and non-experimental research and expert opinion as reflected in systematically identified professional, national and international guidelines, which had been formally assessed by a validated appraisal process. No research designs were specifically excluded but wherever possible, in use rather than in vitro studies were retrieved. All full-text studies were independently assessed by two reviewers who identified those studies meeting the inclusion criteria for critical appraisal.

Halton and Graves (2007) utilized a set of good practice criteria for decision analytic modelling. In all there were 11 criteria that focused on the relevance and coherence of the modelling approach taken in each evaluation: four criteria were used to assess the structure of the model; 6 criteria assessed how data were sourced and incorporated, including

approaches to sensitivity analysis; and 1 criterion to judge how the model was evaluated regarding the terms of its own consistency.

Data collection and analysis
Gillies et al (2005) involved two authors assessing all potentially relevant studies and disagreements were resolved between them by discussion with a third author. Data was collected for the outcomes, infusate contamination, infusate-related bloodstream infection, catheter contamination, catheter-related bloodstream infection, and all-cause bloodstream infection and all-cause mortality. Data was analysed using Review Manager 4.2 to generate meta-analytic data and graphs and pooled estimates were pooled using a fixed effect model. A random effects model was used to find heterogeneity.

Idvall and Gunningberg (2002) analysed the data using a 4-pont scale (i.e. strong scientific evidence; moderately strong scientific evidence; limited scientific evidence; and insufficient scientific evidence) to grade the level of scientific evidence in order to draw valid conclusions.

Centres for Disease Control (2002) – the data collection and analysis methodology are not described in this guideline.

Pratt et al (2007) utilized an adapted data extraction process based on systems developed by the Scottish Intercollegiate Guideline Network (NICE) for study quality assessment. All studies were appraised and data extracted by one reviewer and this was checked by a second reviewer. Evidence tables were developed from the quality assessments and the studies summarised in the evidence reports. Analysis took into account three variables:

- The nature of the evidence
- The applicability of the evidence to practice
- Costs and knowledge of healthcare systems.

Halton and Graves (2007) extracted their data using an audit tool based on the Harvard Cost-Effectiveness Analysis Registry data abstraction forms. The data extracted included a description of the intervention(s) and population studied, the research question, the structure of the economic model and assumptions used, the data used to inform model parameters, the outcomes considered, and the results and conclusions, including the results of sensitivity analyses. Each component of the decision model was analysed: clinical effect size, baseline clinical data, adverse events, resource use, costs and utilities.

Main results
Gillies et al. (2005) found that in their 15 studies which had a total of 4783 participants, there was no evidence that changing intravenous administration sets more often than every 96 hours reduced incidence of bloodstream infection. There were no differences between participants with central versus peripheral catheters, nor between participants who did and did not receive parenteral nutrition, or between adults and children.

Idvall and Gunningberg (2006) found that the samples in 2 of their 3 RCTs included patients who needed total parenteral nutrition. Patients in the third trial received crystalloid and drugs. The time intervals for elective replacement varied. Study quality and relevance were rated as ‘medium’ in two trials and ‘low’ in the third trial.

Centres for Disease Control (2002) – there is no summary of the main results in this guideline. The reader is directed to read the following relevant sections on peripheral intravascular devices:

- Intravascular Catheter-Related Infections in Adult and Pediatric Patients: An Overview
- Epidemiology and Microbiology
- Pathogenesis
- Strategies for Prevention of Catheter-Related Infections in Adult and Pediatric Patients
- Replacement of Catheters
- Special Considerations for Intravascular Catheter-Related Infections in Pediatric Patients

Pratt et al (2007) found that infection control precautions or recommendations should be divided into four distinct interventions:

- Hospital environmental hygiene
- Hand hygiene
- The use of personal protective equipment; and
- Safe use and disposal of sharps

Comprehensive recommendations to prevent HCAI in hospitals and other acute settings have had to include a suggested agenda for further research in each guideline section. National evidence-based guidelines are broad principles of best practice, which should be integrated into local practice guidelines. Implementation must be monitored with key audit criteria for each section of the recommendations.

Halton and Graves (2007) found that 8 studies met their inclusion criteria. Four interventions were found to be clinically effective and cost-saving: use of antibiotic-coated catheters compared with use of either antiseptic-coated or standard catheters, maximal sterile barrier precautions during catheter insertion compared with less stringent aseptic technique, and use of chlorhexidine gluconate as either a skin preparation or impregnated into the insertion site dressing compared with use of povidone-iodine skin preparation and non-impregnated dressings. Results of these evaluations are robust to a wide range of parameter estimates and assumptions.

Reviewers' and guideline developers' conclusions

Gillies et al. (2005) concluded that administration sets that do not contain lipids, blood or blood products may be left in place for intervals of up to 96 hours without increasing incidence of infection. No evidence emerged to suggest that administration sets containing lipids should not be changed every 24 hours as currently recommended.

Idvall and Gunningberg (2006) concluded that despite limited scientific evidence, it can be suggested that elective replacement of peripheral intravenous catheters lessens the incidence and severity of thrombophlebitis. The time *in situ* for a PIC is a known risk factor for developing thrombophlebitis but more clinical trials are needed to provide stronger evidence.

Centres for Disease Control (2002) concluded that guidelines are able to identify performance indicators, which can be used locally by healthcare institutions or organizations to monitor their success in implementing evidence-based recommendations.

Pratt et al (2007) concluded that clinically effective infection prevention and control practice is essential in order to protect patients. Guidelines that are incorporated into routine daily clinical practice will improve patient safety and thereby minimise the risk to patients of their acquiring an infection.

Halton and Graves (2007) concluded that the cost-effectiveness of the interventions they included changed with the use of different parameters and assumptions. The economics of preventing CR-BSI requires further research, particularly for patients in intensive care units. Consensus is required on key issues such as data sources, model structure and evaluation methods.

Key Words: peripheral intravascular devices, catheters, administration set, intravenous therapy, dressings, infection, antisepsis

Abstraction of the evidence and development of practice recommendations

All Joanna Briggs Institute *Best Practice* Information Sheets are a standardised format that includes a background to the clinical question, a summary of the evidence from the systematic review, recommendations and/or implications for practice (graded using the Joanna Briggs Institute Feasibility, Appropriateness, Meaningfulness and Effectiveness scale). The recommendations arising from the evidence in the systematic review and embodied in the *Best Practice* Information Sheets are developed by the *Best Practice* Information Sheets developers with the assistance of the expert advisory panel. Essentially the recommendations for *Best Practice* Information Sheets are where possible evidence based. The developers and the advisory panel consider the evidence and the context in which the evidence may be used and then develop recommendations for practice. Where no evidence is identified in the systematic review the developers and the expert panel develop consensus statements to inform practice. At this point the *Best Practice* Information Sheet is subjected to an extensive review process external to the developers and advisory panel.

Peer review

All Joanna Briggs Institute evidence publications are subjected to a rigorous peer review process. This process begins with the submission of the protocol for the systematic review to the Joanna Briggs Institute Collaboration Support Unit. The protocol is peer reviewed by members of the Support Unit not involved in the review itself. When the systematic review is at draft report stage it is peer reviewed the Joanna Briggs Institute Collaboration Support Unit staff who appraised the protocol initially. In addition the systematic review report is subjected to additional external blinded peer review before publication in the *JBI Library of Systematic Reviews*.

The Collaboration Support Unit along with members of the *Best Practice* review panel and other staff of the Joanna Briggs Institute also review the draft *Best Practice* information sheet. The *Best Practice* information sheet is then distributed to all other Joanna Briggs Collaborating Centres for comment with regard to cultural, professional and organisational issues that may impact on the implementation of the *Best Practice* information sheet recommendations/implications within their constituency.

Best Practice Information Sheets ongoing review/update

All Joanna Briggs Institute evidence publications are based on the best available evidence at the time of publication. When using the publications to inform practice the reader should consider the date of publication and the possibility that recent research may have implications about the strength or direction of recommendations. All Joanna Briggs Institute systematic reviews on which the *Best Practice* Information Sheets are based are assessed for update at five years post publication and at this time the relevant *Best Practice* Information Sheets is also reviewed.

Funding

Although the majority of Joanna Briggs Institute systematic reviews and *Best Practice* Information Sheets are funded by corporate membership funds and/or by the Joanna Briggs Collaborating Centres, external funding is occasionally used. In these cases the internal and external peer review processes ensure that editorial independence from the funding body is maintained.

Conflict of interest

Any conflict of interest by Joanna Briggs Collaborating Centre staff and/or advisory panel members is declared in a statement within the systematic review report.

Appendix 1 – Grades of Recommendation and Implications for Practice

It is the policy of the Joanna Briggs Institute that all *Best Practice* Information Sheets will utilise the Joanna Briggs Institute Grades of Recommendation with the specific hierarchy corresponding to the implication for practice provided. See recommendation tables below.

Implications for Practice	Feasibility	Appropriateness	Meaningfulness	Effectiveness
A	Strong support that merits application	Strong support that merits application	Strong support that merits application	Strong support that merits application
B	Moderate support that warrants consideration of application	Moderate support that warrants consideration of application	Moderate support that warrants consideration of application	Moderate support that warrants consideration of application
C	Not supported	Not supported	Not supported	Not supported

The following implications for this *Best Practice* Information Sheet are based on the JBI developed **Grades of Effectiveness** (column far right above):

- Healthcare professionals will need ongoing education, training and assessment regarding the insertion and management of peripheral intravascular devices; preferably, designate trained personnel to insert and maintain intravascular devices **(Grade A)**
- Vigilance in handwashing and septic technique is vital, particularly for palpitating, inserting, replacing or dressing an intravascular device **(Grade A)**
- Choose catheters based on intended purpose and duration of use, known complications and experience – Teflon, silicone elastomer or polyurethane catheters are safer than polyethylene, polyvinyl chloride or steel needles, which may cause necrosis if extravasion occurs **(Grade A)**
- Replace IV tubing, including piggyback tubing, no more frequently than at 72 hour intervals, unless clinically indicated or advised **(Grade B)**
- Routinely flush peripheral venous cannula bungs with normal saline solution, unless they are used to obtain blood specimens, in which case a dilute heparin flush solution should be used **(Grade B)**
- It is advised to use transparent dressing or sterile gauze to cover the catheter site **(Grade B)**

Appendix 2 - Table of included studies

Gillies et al. systematic review

Study	Study Method	Participants	Interventions	Outcomes
Blight 1998	Randomised controlled trial	769 ICU patients with a CVC containing crystalloids, PN, lipid or drugs; ICU, Australia	Administration set changes at 72 or 120 hours	Catheter colonisation, CR-BSI
Buxton 1979	Randomised controlled trial	600 patients with new infusions begun the previous 24 hrs; 4 general medical wards and 4 general surgical wards in a general hospital, USA	Administration set changes at 24 or 48 hours	Infusate colonisation, all-cause BSI
DeMoissac 1998	Randomised controlled trial	50 cancer patients with tunnelled CVC; urban cancer centre, Canada	Administration set changes at 24 or 48hours	Infusate colonisation, IR-BSI
Fox 1999	Randomised controlled trial	166 neonates receiving TPN, NICU, Canada	Administration set changes at 24 or 48 hours	IR-BSI, all-cause BSI, all-cause mortality
Gorbea 1984	Alternately allocated controlled trial	123 adult patients in surgical ICU requiring IV therapy; hospital, USA	Administration set changes at 24 or 48 hours	Infusate colonisation, IR-BSI, CR-BSI, all-cause BSI
Jakobsen 1986	Randomised controlled trial	325 patients to receive IV therapy for at least 3 days; 3 surgical and 5 medical centres, Denmark	Administration set changes at 24, 48, 72, 96 or 120 hours	Catheter colonisation
Josephson 1985	Randomised controlled trial	173 patients with IV therapy in previous 24 hrs; university hospital, USA	Administration set changes at 48 hrs or no change for remainder of cannula placement (i.e. 72 hours)	Infusate colonisation, IR-BSI
Maki 1987	Randomised controlled trial	487 patients in general surgical, medical oncology, surgical ICU; acute care hospital, USA	Administration set changes at 48 or 72 hours	IR-BSI, all-cause BSI
Matlow 1999	Randomised controlled trial	1189 neonates in NICU to have IV lipid therapy; NICU, Canada	Administration set changes at 24 or 72 hours	BSI-related mortality, all-cause mortality
Raad 2001	Randomised controlled trial	428 cancer patients needing IV therapy; tertiary uni cancer centre, USA	Administration set changes at 72 or 96-168 hours	Infusate colonisation, IR-BSI, CR-BSI

Rickard 2004	Randomised controlled trial	251 ICU patients with a CVC	Administration set changes at 72 or no change up to 144 hrs	Catheter colonisation, CR-BSI
Stiges-Serra 1985	Randomised controlled trial	52 adult surgical patients having PN through subclavian catheter; hospital, Spain	Administration set changes at 48 or 96 hours	IR-BSI, catheter colonisation, CR-BSI
Snydman 1987	Alternately allocated controlled trial	170 adult patients in medical and surgical ICUs, USA	Administration set changes at 48 or 72 hours	IR-BSI, CR-BSI, all-cause BSI

Idvall and Gunningberg systematic review

Study	Study Method	Intervention: elective replacement of peripheral intravenous catheters	Outcomes
Barker et al 2004	Randomised controlled trial	47 patients received intravenous saline solution and/or medication at a department of general medicine or general surgery	Incidence of thrombophlebitis
Kerin et al 1991	Randomised controlled trial	51 consecutively selected patients received TPN	Average daily Maddox score
May et al 1996	Randomised controlled trial	60 consecutively selected patients received TPN	Thrombophlebitis score

Centres for Disease Control guideline

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Pratt et al. guideline

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May et al 1996	Randomised controlled trial	60 consecutively selected patients received TPN	Thrombophlebitis score

Halton and Graves economic evaluation

Study	Study Method	Intervention	Comparator	Hospitalised Patients	Time Horizon
Marciante, Veenstra, Lipsky & Saint 2003	Economic evaluation	Antimicrobial catheters MR CVC	CHG-SSD CVC	Adults at high risk of CR-BSI likely to require a triple-lumen, non-cuffed CVC for ≥3 d	Patient lifetime
Shorr, Humphreys & Helman 2003	Economic evaluation	MR CVC and CHG-SSD CVC	Standard CVC	Critically ill patients requiring a CVC expected to be placed >48 h	Duration hospitalised
Veenstra, Saint & Sullivan 1999	Economic evaluation	CHG-SSD CVC	Standard CVC	Patients at high risk for catheter-related infections requiring short-term use (2-10 d) of multi-lumen CVCs	Duration hospitalised
Hu, Veenstra, Lipsky & Saint 2004	Economic evaluation	Aseptic technique: MSB at CVC insertion	Less stringent asepsis	Patients requiring short-term multi-lumen CVC (specifically those in ICUS with immunosuppression, or receiving TPN)	Duration hospitalised
Chaiyakunapruk et al 2003	Economic evaluation	Skin preparation and dressing: CHG skin prep	PI skin preparation	Patients requiring either a PVC or CVC (considered separately) for short-term use (<10 d)	Duration hospitalised

Crawford, Fuhr & Rao 2004	Economic evaluation	CHG dressing	Standard dressing	Patients at high risk for catheter-related infections requiring short-term use (2-10 d) of multi-lumen CVCs	Duration hospitalised
Durand-Zaleski et al 1997	Economic evaluation	TPN commercial bags	TPN glass bottles	Patients receiving TPN through catheter for severe bowel dysfunction secondary to Crohn	Duration hospitalised
Ritchey et al 1995	Economic evaluation	Replacement regimen: Optimal CVC change regimen (10 d, 5 d)	3-d change regimen	65 year-old man in ICU with irreversible disease process	Duration hospitalised

Appendix 2 – References

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