



Review

Epidemiology of catheter-related infections in adult patients receiving home parenteral nutrition: A systematic review[☆]Mira Dreesen^{a,*}, Veerle Foulon^b, Isabel Spriet^a, Godelieve Alice Goossens^c, Martin Hiele^d, Lutgart De Pourcq^a, Ludo Willems^a^a Department of Pharmaceutical and Pharmacological Sciences, Research Centre for Clinical Pharmacy, University Hospitals Leuven, Leuven, Belgium^b Department of Pharmaceutical and Pharmacological Sciences, Research Centre for Pharmaceutical Care and Pharmaco-economics, KU Leuven, Leuven, Belgium^c Department of Surgical Oncology, University Hospitals Leuven, Belgium, Center for Health Services and Nursing Research, KU Leuven, Leuven, Belgium^d Department of Gastroenterology, University Hospitals Leuven, Leuven, Belgium

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SUMMARY

Background and aims: Catheter-related infection (CRI) is the most common and serious complication for adult patients receiving home parenteral nutrition (HPN). Our aim is to provide epidemiological data on infection incidence, infecting pathogens and contributing risk factors.

Methods: Four electronic databases (Embase, Medline, IPA, CINAHL) were screened for eligible studies published between 1970 and March 2012. Methodological quality was evaluated and terminology/definitions were re-categorized.

Results: Thirty-nine studies were included. Extensive variability was observed in terminology/definitions as well as in expression of CRI rate. After correct interpretation of definitions, overall catheter-related bloodstream infection rate (CRBSI) ranged between 0.38 and 4.58 episodes/1000 catheter days (median 1.31). Gram-positive bacteria of human skin flora caused more than half of infections. An analysis of the reported risk factors showed that the origin of a CRBSI is often multifactorial. The risk factors were related to the patient, the venous access device, the education, HPN therapy and follow-up.

Conclusions: This review on CRI in adult HPN patients revealed that included studies are of low quality and used poorly described risk factors and different definitions. The human skin flora caused most of infections; therefore, hand hygiene and training remain essential.

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1. Introduction

Home parenteral nutrition (HPN) is a therapy for patients with severe or long-term intestinal failure. These patients are unable to receive their nutritional requirements by oral intake and/or enteral tube feeding but are clinically stable enough to leave the hospital. HPN can be life-saving or life-extending as all nutrient requirements are administered systemically. For adequate venous access, the presence of a central venous catheter (CVC) is necessary. In general, two types of venous access devices are used: i.e. catheters

for short-term or long-term use. As HPN patients usually receive therapy during a long period of time, tunneled catheters and infusion ports are mostly used.¹ Peripherally inserted CVC's (PICCs) are only preferred if the estimated duration of HPN is limited to 12–18 months.²

The most common venous access-related complications for HPN patients are infection, thrombosis, functional complications (for example total occlusion) and pneumothorax.³ Catheter-related infections are the most serious threat.^{3,4} These infections include both local and systemic infections. Local infections are exit-site, tunnel and pocket infections. Generalized systemic infections include catheter-related bloodstream infection (CRBSI). The latter is defined as isolation of the same organism from semi-quantitative or quantitative cultures of both blood drawn from the catheter lumen and the blood peripherally drawn of the patient with clinical symptoms of a bloodstream infection and no other apparent source of infection.^{5,6} The major causes of CRBSI are contamination of the catheter hub and migration of the skin organisms at the insertion site into the catheter tract.⁵ Important determinants of CRBSI are

Non-standard Abbreviation: PN, parenteral nutrition; HPN, home parenteral nutrition; CVC, central venous catheter; CRBSI, catheter-related bloodstream infections.

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the material of the device, the intrinsic virulence factors of the infecting organism and protein adhesions, such as fibrin and fibronectin, which form a sheath around the catheter.⁶

Catheter-related infections can lead to an increased morbidity and mortality. Moreover, these infections usually require hospital admission and cause high costs for the healthcare system.⁷ Therefore a better understanding of the epidemiology of these infections is necessary to prevent harm. The aim of this review is to provide an overview of catheter-related infection rates, causative pathogens and associated risk factors.

2. Methods

2.1. Search strategy

Four electronic databases (Embase, Medline, the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and International Pharmaceutical Abstracts (IPA)) were screened for studies concerning catheter-related infections of adult HPN patients, published between 1970 and March 2012. The following search string was used: (total parenteral nutrition, home OR home parenteral nutrition OR home total parenteral nutrition OR home ambulatory nutrition OR home infusion therapy) AND (catheterization, central venous OR catheters, indwelling OR central venous access) AND (sepsis OR infection OR catheter-related infection OR catheter-related infection OR catheter-related bloodstream infection). In Embase, we searched with corresponding Emtree terms: (home parenteral nutrition) AND (indwelling catheter OR central venous catheterization OR central venous access) AND (catheter infection). First, titles and abstracts were screened. Thereafter, the full-text manuscripts were read and analyzed. Relevant papers cited in the bibliographies of primary candidate papers were culled for further review. Only studies conducted in adult patients (≥ 17 year) receiving home parenteral nutrition via a central vein were included. When the age range was not mentioned, the author was contacted. If this was not possible, the mean age of the studied population had to be above 45 years. Case reports were only included if information on microbiology was provided.

2.2. Methodological quality

No consensus is available about the tools that should be used to assess the quality of observational studies. The different tools used during the last decade have been described in a recent review.⁸ We selected a tool⁹ applicable for studies of incidence/prevalence and for studies describing risk factors. This tool evaluated the strength of evidence, based on four criteria: i.e. time relationship, case-finding strategy, case definition and source of diagnosis. In order to use the tool, we adapted these criteria for studies with HPN patients.

2.3. Data extraction

The following data were extracted from each included publication: (1) study characteristics, (2) patient characteristics, (3) definition of catheter-related infections, (4) incidence of catheter-related infections, (5) microbiology and (6) potential associated risk factors. Study characteristics consisted of geographic area, number of catheter days (total, median/mean, range) and number and type of catheters. Patient characteristics included age (mean, median, range), gender and type of underlying disease (benign or malignant).

2.4. Analysis of the definition and terminology

To allow a correct review of the included studies, all terminology and definitions describing catheter-related infections and sepsis, used in each individual study, were re-categorized into two main categories, according to the accepted definitions^{5,6} in literature:

1. Catheter-related bacteremia (CRB): isolation of the same organism for semi-quantitative or quantitative cultures of both blood drawn from the catheter lumen and blood drawn from a peripheral vein.
2. Catheter-related bloodstream infection (CRBSI): isolation of the same organism for semi-quantitative or quantitative cultures of both blood drawn from the catheter lumen and blood drawn from a peripheral vein of a patient with clinical symptoms of a bloodstream infection.

2.5. Analysis of the catheter-related infection rate

In general, catheter-related infection rate or catheter-related sepsis rate or catheter-related bloodstream infection rate is expressed as the number of catheter-related episodes per 1000 catheter days. This is the ratio of the number of catheter-related episodes of infection to the total number of catheter days during the study period multiplied by 1000. Some studies expressed the rate on a different manner and, if possible, recalculation was done by the first author of this review. For example, patient-years were defined as 365 catheter days.

3. Results

3.1. Results of search strategy

Searches in Embase, Medline, CINAHL and IPA identified 45, 174, 77 and 84 studies, respectively. There were 326 unique studies of which 71 were retained after evaluation of the relevance of titles and abstracts (Fig. 1). Finally, full-text evaluation resulted in inclusion of 39 publications. Nine of these were found through manual search of bibliographies.

3.2. Characteristics of selected studies

Characteristics of the included studies are summarized in Table 1. All studies were performed and published between 1984 and March 2012. The studies were carried out in 14 different geographical regions and countries, respectively in the USA ($n = 10$), Italy ($n = 7$), Canada ($n = 5$), United Kingdom ($n = 4$), Korea ($n = 2$), the Netherlands ($n = 2$), New Zealand ($n = 2$), Brazil ($n = 1$), Denmark ($n = 1$), Europe ($n = 1$), Germany ($n = 1$), Japan ($n = 1$), South Africa ($n = 1$) and Taiwan ($n = 1$). Most studies ($n = 23$) included less than 50 patients; only 7 studies^{10–16} did include 150 patients or more (range 150–481). In general, more men than women were included and more patients with benign underlying disease were enrolled. The most frequent benign indications were Crohn's disease and short bowel syndrome. The age of the included patients ranged between 17 and 93 year. For venous access, 1796 tunneled catheters were used; 1061 implantable port devices and 143 PICCs were placed (Fig. 2).

3.3. Quality of included studies

There were ten prospective studies^{7,15,17–24} and 21 retrospective.^{10–16,25–40} There were two case-control studies,^{41,42} one randomized placebo-controlled trial⁴³ and four case reports^{44–47};

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