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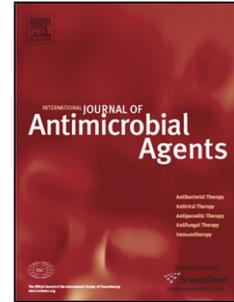
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Selection of the vascular catheter: can it minimize the risk of infection?

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Abstract

Data regarding the prevention of catheter-related bloodstream infection (CRBSI) by making the correct decisions about when to place a central line, the appropriate selection of catheter composition and the size and number of lumens, a suitable choice of insertion site and the technique used are not well reported in recent medical literature. There is no clear evidence that the composition of the catheters presently on the market makes a significant difference to the risk of infection. Several prospective studies suggest that femoral vein location represents the highest risk of infection, followed by jugular vein and subclavian vein positioning, however, most articles do not correct for basic confounding variables. Several papers have reported that arterial catheters have a similar risk of infection as central venous catheters (CVCs). The slight increase in infection risk when using multi-lumen catheters is probably offset by their improved convenience. Current evidence does not support routine tunnelling of short-term catheters until its efficacy is evaluated at different placement sites, using specific catheters and situations and in relation to other preventive interventions. Cuffing is usually applied only to long-term tunnelled catheters. The available evidence suggests that chlorhexidine–silver sulfadiazine, minocycline–rifampicin CVCs and antifungal-coated catheters are useful in decreasing the incidence of CRBSI when other measures are not effective.

Keywords:

Catheter-related bloodstream infections

Selection of catheters

Bacteraemia

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1. Introduction

Catheter-related bloodstream infections (CRBSI) are a major problem in the area of infection control [1–5]. Programmes to minimize the risk of CRBSI are founded in the systematic application of bundles of care and the implementation of well-established procedures in both the placement of the catheter and its subsequent care [6].

Daily assessment of the need for a central line and adequate and early removal of the catheter are important aspects of these bundles. However, data regarding the prevention of infection achieved by correct decisions about when to place a central line, the appropriate selection of catheter composition and the size and number of lumens, a suitable choice of insertion site and the technique used are not so well reported in recent medical literature [7]. Our aim is to review several issues regarding the prevention of CRBSI, mainly those around the catheter and its characteristics.

2. Catheter material

There is no clear evidence that the composition of the catheters presently on the market makes a significant difference to the risk of infection.

Selection of the material is mainly performed on the basis of elasticity, resistance to breakage, risk of obstruction and clinical parameters. Moretti et al. stated [8] that infection rates may depend more on non-catheter-related factors, such as adherence to infection control standards, selection

of the insertion site, duration of catheter placement and frequency of dressing changes.

3. Location of catheter insertion

Central venous catheters (CVCs) are usually indicated when peripheral veins are inaccessible or when administering vasoactive drugs, irritating solutions or parenteral alimentation. They are also required for haemodialysis or haemofiltration and for hemodynamic monitoring.

The selection of the location for CVC insertion is not generally taken on the basis of the risk of infection but on the medical need and the risk of complications during the insertion or maintenance of the catheter. It is not clear if clinical experience in catheter implantation and the number of insertion attempts may influence the risk of infection. Whenever possible, catheters should not be inserted through the site of burns or infection.

No randomized trials have been performed to assess a clear superiority of one location over another [9]. However, several prospective studies using multivariate analysis suggest that femoral vein location represents the highest risk of infection, being greater than jugular vein location, and the risk with jugular insertion being greater than location in the subclavian vein [10–16]; however, most articles do not correct for basic confounding variables. Deshpande et al. [16] assessed the risk of CVC infection with respect to the site of insertion in an intensive care unit (ICU) population. The subclavian, internal jugular and femoral sites were studied in a prospective epidemiological observation study. The optimal insertion site

for each patient was selected by the intensive care physicians. A total of 831 CVCs and 4735 catheter days in 657 patients were studied. The incidence of catheter infection and colonization was low overall and no statistically significant differences in the incidence of infection and colonization or duration of catheters among the insertion sites were found.

Until recently, the literature suggested that arterial catheters may have a lower infection risk than catheters located in central veins [17–19]. However, since 2005, several papers have reported that arterial catheters have a similar risk of infection as CVCs [20–22]. Lucet et al. [20] reported a study from seven French ICUs collecting 3532 catheters and 27 541 days of observation. The rates of colonization for arterial catheters and CVCs were 11.4 and 11.1/1000 days of exposure, respectively. Regarding the risk of infection, the figures were 1.0 and 1.1/1000 days for arterial catheters and CVCs, respectively.

Koh et al. [21] prospectively measured colonization and rates of CRBSI in arterial catheters in comparison with CVCs cared for in the same way. Overall, 301 arterial catheters in 252 adult and paediatric patients were observed for 1082 catheter days, and 618 central venous catheters in 410 patients were observed for 4040 catheter days. Arterial catheter colonization was not significantly different to that in CVCs. The arterial catheter should be accorded the same degree of importance as the CVC as a potential source of sepsis.

Table 1, modified from a meta-analysis published by Maki et al. in 2006 [7], compares the incidence and incidence density of infections in different catheter locations. Overall, the authors demonstrated the need to express the risk of catheter infection as incidence density, avoiding the bias produced by comparing plain incidence. For instance, comparing incidence densities, steel needles carry a higher risk for 1000 days of exposure (8.6) than peripherally inserted CVCs (0.5).

[Table 1 here]

4. Number of lumens in the catheter

The number of lumens should be chosen to meet clinical needs. Multi-lumen catheters are commonly selected to avoid multiple CVC sites. The higher the number of lumens and the longer the catheter, the higher the resistance to flow. Dialysis catheters are typically double-lumen large-bore catheters because of the high flow rates required for dialysis.

Multi-lumen central venous catheters may be associated with a slightly higher risk of infection when compared with single-lumen catheters.

However, this relationship diminishes when only high-quality studies that control for patient differences are considered. The slight increase in infection risk when using multi-lumen catheters is probably offset by their improved convenience, thereby justifying the continued use of multi-lumen vascular catheters [23].

Nevertheless, the use of catheters with multiple lumens should be restricted, and if a catheter cannot be removed the permanent closure of unneeded lumens may reduce the risk of CRBSI [24,25].

5. Tunnelled versus non-tunnelled catheters

A meta-analysis of randomized controlled trials comparing tunnelling short-term CVCs to prevent catheter-related infection showed that tunnelling may decrease the infection rate. However, current evidence does not support routine tunnelling until its efficacy is evaluated at different placement sites, using specific catheters and situations and in relation to other preventive interventions [26].

Most information regarding tunnelling of catheters has been collected in adult patients. Nahum et al. [27], in a study of bacterial colonization of femoral CVCs in critically ill children, found that the tip colonization rate was higher in tunnelled catheters, but they were unable to demonstrate significant differences in the rates of CRBSI.

6. Cuffed vs non-cuffed catheters

There is no clear evidence that cuffing of short-term catheters significantly decreases the incidence of CRBSI. Cuffing is usually applied to long-term tunnelled catheters.

Flowers et al. in 1989 [28] reported a randomized controlled trial of an attachable subcutaneous cuff for the prevention of CVC-related infection among patients receiving intensive care. Catheters were placed into new sites with or without a cuff and were dressed with antibiotic ointment

containing polymyxin, neomycin and bacitracin. Microbial colonization developed in 34.5% of 29 control catheters and 7.7% of 26 cuffed catheters. CRBSI occurred with 13.8% of control vs. 0% of cuffed catheters. These data suggested that the cuff could reduce the incidence of catheter-related infection among high-risk patients receiving catheter-site care with an antibacterial ointment.

By contrast, Groeger et al. [29] evaluated the effect of a silver-impregnated cuff on the incidence of catheter-related bacteraemia/fungaemia or tunnel tract infection in 200 randomly selected cancer patients with chronic dual-lumen tunnelled venous access catheters. The hazard rate for infection/day was not significantly different and the study indicated that a silver-impregnated cuff did not decrease the incidence of catheter-related bacteraemia/fungaemia.

More recently, Trerotola et al. [30] randomized 84 patients to receive a 5F single- or 6F dual-lumen small-bore central catheter with or without a polyester cuff. The overall infection rate was 0.4 per 1000 catheter days and cuffing did not make any difference to the risk of infection in jugular small-bore catheters. Cuffed catheters were no more difficult to insert but took slightly longer to remove and often required local anaesthesia for removal.

7. Totally implanted vs non-implanted catheters

Totally implanted catheters are generally accepted as carrying a lower risk for CRBSI [7,31,32]. However, no properly performed comparative

studies permit us accurately to assess the difference. In general, totally implanted catheters are accessed less frequently, are usually associated with more precautions and are inserted by more specialized healthcare workers than open catheters. An infection incidence density of 0.1 episodes/1000 days in place has been reported [7].

Prospective studies suggest that there are no major differences in risk of infection between valved and non-valved totally implantable catheters or between low-profile and conventional devices [33,34].

A randomized comparison of complications from three different central venous access systems was not able to demonstrate significant differences between polyurethane ChemoSite, polyurethane Port-a-Cath and silicone Port-a-Cath devices [35].

8. Antimicrobial-coated catheters

The greatest amount of literature regarding catheter types in recent years has been devoted to the potential decrease of the risk of infection in catheters coated with various antimicrobial substances [36,37]. Ramritu et al. [38] performed a systematic review comparing the relative effectiveness of antimicrobial-coated catheters in ICUs. Another excellent review is by Casey et al [39]. In summary, the first-generation externally coated chlorhexidine–silver sulfadiazine CVCs reduced colonization and CRBSI when compared with non-coated catheters. Externally and internally coated catheters were superior to those coated only externally. Antibiotic-coated catheters (minocycline–rifampicin) were superior to

those coated with chlorhexidine–silver sulfadiazine in reducing colonization and CRBSI.

A cohort study by Lorente et al. [40] showed a drastic reduction of CRBSI in femoral and jugular CVCs using rifampicin–miconazole-impregnated catheters compared with standard catheters (0 vs 8.62 cases/1000 catheter days for femoral catheters and 0 vs 4.93 cases/1000 catheter days for jugular catheters).

Despite the shortcomings of the studies of antimicrobial-coated catheters, the available evidence suggests that chlorhexidine–silver sulfadiazine, minocycline–rifampicin CVCs and antifungal-coated catheters are useful if the incidence of CRBSI is above institutional goals despite full implementation of infection prevention interventions.

The role of silver particles in protecting CVCs from colonization and reducing the risk of CRBSI is not yet clear [41,42,43]. In a prospective, randomized, non-blinded, controlled study Hagau et al. [44] found no significant difference in colonization and CRBSI per 1000 catheter days but a potential delay in colonization in silver-impregnated vs standard catheters. Whereas standard catheters were first colonized 3 days after insertion, silver-impregnated catheters were first colonized 5 days after insertion.

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2009; 26: 752–8.

Table 1

Incidence and incidence density of catheter-line associated bloodstream infection (CLABSI) with different types and location of catheter (modified from Maki et al. [7])

Devices	No. of studies	CLABSI rate	
		Per 100 devices Pooled mean	Per 1000 days. Pooled mean
Plastic peripheral catheters	110	0.1	0.5
Steel needles	1	2	8.6
Venous cutdown	1	3.7	9
Midline catheters	3	0.4	0.2
Arterial catheters	14	0.8	1.7
CVCs short-term, non-cuffed, non-tunnelled	79	4.4	2.7
CVCs short-term, non-cuffed, tunnelled	9	4.7	1.7
CVCs chlorhexidine–silver sulfadiazine	18	2.6	1.6
CVCs minocycline–rifampicin	3	1	1.2

rifampicin			
CVCs silver	2	5.2	4.7
impregnated			
CVCs silver	2	4	3.3
iontophoretic			
Haemodialysis,	16	8	4.8
temporary, non-cuffed			
Haemodialysis, long-	16	21.2	1.6
term, cuffed, tunnelled			
CVCs cuffed, tunnelled	29	22.5	1.6
Ports, central	14	3.6	0.1
Ports, peripheral	3	4	0.1

CVC, central venous catheter.