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REVIEW

Diagnosis of central venous catheter related infection in adult patients

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Abstract Intravascular catheters are one of the main causes of bacteraemia and septicaemia in hospitalised patients and continue to be associated with a significant morbidity and mortality. Two main types of infections occur, they can be either localised at the catheter insertion site of systemic with a septicaemia. The clinical parameters related to these infections are presented. The laboratory diagnosis of these infections is also extensively reviewed and recommendations are made as to the most appropriate diagnostic method to be used.

Introduction

Synthetic intravascular catheters were introduced into clinical practice in the 1940's[1] and are now an essential part of patient management.[2,3] It is estimated that 150 million intravascular devices are used in the U.S.A. per annum of which 5 million are central venous catheters (CVC).[4,5] In the U.K., approx. 200 000 CVC are inserted each year.[6] Intravascular devices are, however, associated with early or late onset complications. Early onset complications include localised trauma, haematoma, vessel perforation, air embolism and haemorrhage, whereas late onset complications include thrombosis and more commonly infection.[7] Infections can be local at the site of insertion of the intravascular device or systemic. Occasionally, metastatic infection including lung abscess, osteomyelitis, endopthalmitis and endocarditis can ensue.[8]

In the U.S.A. alone it is estimated that between 200 000 and 400 000 nosocomial bloodstream infections occur each year.[9] The majority of these infections are associated with intravascular access with substantially higher rates among patient with CVC as compared to peripheral devices.[9,10] The risk of catheter related infection (CRI), which may present as localised infection confined to the catheter and surrounding tissue, and/or systemic infection, varies with the type of catheter, location of insertion site, duration of catheter placement and the patient's degree of immunosuppression such as neutropaenia.[11,12] The common types of

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Table 1 Common types of central venous catheter and associated clinical use

Duration of catheter insertion	Catheter type	Clinical use
Short term (<10 days in situ)	Non-cuffed multilumen. Percutaneously inserted into central veins (subclavian, internal jugular, femoral)	Drug and fluid administration; right heart monitoring
	Dual lumen haemodialysis (cuffed and non-cuffed); percutaneously inserted into central veins (subclavian, internal jugular, femoral)	Haemofiltration/haemodialysis
	Swan sheath	Teflon® introducer for Swan Ganz catheter; fluid infusion
	Balloon tipped pulmonary artery (Swan Ganz); inserted through a Swan sheath into a central vein (subclavian, internal jugular, femoral)	Cardiac output investigation; left heart monitoring
Long term (>10 days in situ)	Cuffed and tunneled (Hickman, Broviac, Groshong, Quinton); non-tunneled (Portacath); implanted into subclavian, internal jugular or femoral veins	Administration of chemotherapy, drugs, fluids; venous blood sampling; total parenteral nutrition
	Peripherally inserted central catheter (PICC); inserted into basilica, cephalic or brachial veins and enter the superior vena cava	Administration of chemotherapy, drugs, fluids; venous blood sampling; total parenteral nutrition

CVC, insertion details and their application in clinical practice is given in Table 1.

The reported incidence CRI is variable and ranges from 0 to 18%.[7] Catheters associated with the greatest risk of infection are the short term non-cuffed single or multilumen CVC inserted percutaneously into the subclavian or internal jugular vein. The incidence of CRI associated with these devices is 3–5% (2–3 episodes per 1000 catheter days),[9,12,13] which rises to over 30 per 1000 CVC days in patients with burns.[14] However, far lower infection rates occur with surgically implanted cuffed devices (e.g. Hickman, Broviac) and long term tunneled devices (e.g. Port-A-Cath) which are associated with 1.0 and 0.2 episodes per 1000 catheter days, respectively. Prospective studies have also demonstrated that CRI have an attributable mortality ranging from 12 to 25%[15,16] and an added annual healthcare cost of $60–$460 million.[12] In the U.K., the cost of infections associated with short term CVC is estimated to be between £5 and £7 million per annum.[17]

The micro-organisms which are commonly associated with colonization of catheters and subsequent infection may gain access to the intravascular device through various routes. Common routes of access include; extraluminal, following manipulation of the device by patients and/or healthcare workers; intraluminal, via contaminated catheter hubs and infusates; impaction at the time of insertion and haematogenous colonization from a distant, unrelated site of infection.[7] The types of micro-organism that cause CRI vary over time and with the type of device used.[8,12] However, over the past two decades, the staphylococci have been consistently associated with the majority of infections. In short term non-cuffed CVC devices, the coagulase negative staphylococci (CNS) and *Staphylococcus aureus* account for approx. 39 and 26% of cases of CRI, respectively, whilst the Gram-negative bacilli are associated with 14% of cases and 11% are attributed to *Candida* species. In addition, the enterococci now account for approx. 13% of cases of bloodstream infections associated with intravascular devices.[8] This figure has steadily increased over the past decade and is likely to be associated with antibiotic use. Conversely, in long term surgically implanted CVC including tunneled (e.g. Hickman, Broviac), non-tunneled (e.g. Port-A-Cath and peripherally inserted central venous catheters (PICC)), the Gram-negative bacilli account for almost 50% of cases usually following intraluminal access to the devices.[12]

Rapid and accurate diagnosis of CRI is therefore essential for providing both optimal patient care and management, and reducing additional healthcare costs related to anti-microbial therapy and extended hospitalisation. There is, however, a wide range of approaches used for the diagnosis of CRI associated infection.[18,19] In this review, the diagnosis is considered in two sections; clinical and laboratory investigations.

Clinical diagnosis of catheter-related infections

The clinical diagnosis of CRI is complex as the clinician is often presented with a febrile patient