Central venous catheter-related infection – back to basics

Intravascular devices are an integral component of modern-day medical practice. They are used to administer intravenous fluids, medications, blood products and parenteral nutrition. In addition, they may serve as a useful adjunct in monitoring the haemodynamic status of critically ill patients.[1] Central venous catheters (CVCs) are extensively used worldwide. Currently, an estimated 27 million CVC insertion procedures are performed annually. In 2020, the global CVC market size was valued at USD763 million, with this market expected to grow to USD1.6 billion over the next 5 years.[2] In the USA alone, more than 5 million CVCs are utilised each year, accounting for at least 15 million CVC days.

The advent and evolution of CVCs have represented a major advance in terms of patient comfort and care, but with them has come the burden of complications, including a variety of local and systemic infectious complications.

In this issue of the *AJTCCM*, Glover and colleagues[3] share data from an important and relevant retrospective study evaluating central line-associated bloodstream infections in a multidisciplinary academic hospital in South Africa (SA). A high incidence of central line-associated bloodstream infections was documented. The authors conclude that urgent intervention is required to reduce the high incidence of infection.

Several guidelines pertaining to the prevention and management of intravascular catheter-related infections (CRI) exist. CRIs, however, remain among the top causes of hospital-acquired infection and are associated with prolonged hospitalisation, increased medical costs and mortality. Device-associated infection rates, including those related to CVCs, have been reported to occur with much greater frequency in developing countries compared with pooled data from the USA.[4-6]

CVCs account for an estimated 90% of all catheter-related bloodstream infections (CRBSI) and a host of risk factors have been documented.[1]

Given the magnitude and seriousness of the problem of CRI, it is essential for healthcare workers involved with their use, to have a full appreciation of the diagnosis, pathogenesis, prevention and treatment of this problem and of new developments in the field. Most of these infections can be reversed with appropriate diagnosis and treatment and, of particular relevance, many can be prevented.

Various simple and basic interventions in conjunction with stringent compliance thereof, will assist enormously in helping to address problems associated with CVC care and limit line-related infective complications. The pathogenesis and routes of infection involved in central venous catheter-related infection are shown in Fig 1. Recognition of these elements underpin the basic processes and procedures required to enhance and improve CVC care and ameliorate the burden of CRIs and their sequelae.

Measures to prevent CRI include, very importantly, appropriate infection control actions such as proper hand hygiene, skin antisepsis, maximal barrier precautions and timely removal of catheters when their use is no longer required. The use of catheter teams, protocols, checklists and bundles all help to prevent complications. Catheter site inspection and evaluation should form part of the routine
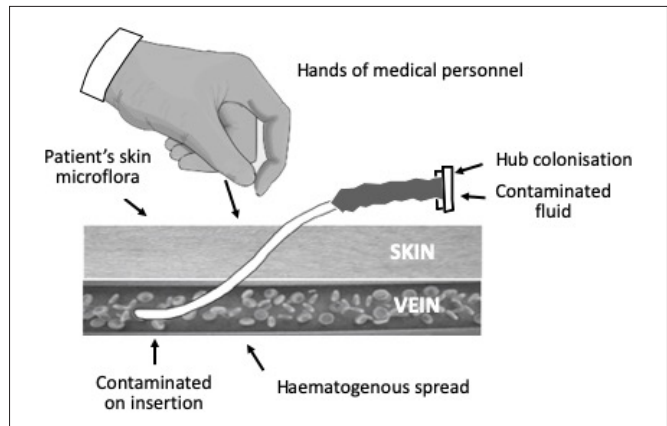

Fig. 1. Pathogenesis of central venous catheter-related infections.

daily examination task of every patient. Where feasible, ultrasound guidance should be utilised to assist with catheter placement.

Two recent studies indicate the superiority of chlorhexidine-alcohol compared with povidone-iodine-alcohol for skin disinfection prior to catheter insertion.[7,8] The use of antimicrobial-impregnated catheters has in recent years been advocated by some guidelines, particularly in settings where high rates of CRI exist, as a means of reducing such infections. A large SA randomised, prospective, double-blind study spanning ~35 000 catheter hours in critically ill patients, demonstrated that antimicrobial-impregnated catheters did not provide any significant benefit over standard catheters.[9] Additionally, this study demonstrated that standard CVCs could safely be kept in place for up to 14 days, with appropriate infection control measures. Furthermore, the site of insertion was not shown to be a risk factor for CRI. A recent expert consensus clinical practice guideline relating to critically ill patients, in keeping with the SA study findings, recommends against the use of antimicrobial-impregnated CVCs to decrease the incidence of infection.[10] Disinfecting port protectors are useful adjuncts and in various studies have been shown to be effective in reducing CRBSI. Simple port protectors include 70% isopropyl alcohol-containing caps that twist onto the CVC extension access points, providing rapid disinfection and protection for up to 7 days. These disinfecting port protectors serve as a physical barrier, avoid technique variation, provide visual compliance confirmation, are easy to apply, stay securely in place and are cost-effective. In terms of CVC dressings, chlorhexidine-impregnated dressings have been shown to be useful in limiting CRI and CRBSI. Newer-generation dressings have been designed to enhance insertion site visibility, promote evaporation and breathability, as well as to improve catheter securement. In resource-restricted settings or where newer dressings are not available, sensible alternative and effective protocols are available and have been shown to be effective.[1,9]

As a general rule of thumb, if a CRBSI is suspected or confirmed, the catheter must be removed. Adequate duration of appropriate antibiotic treatment in confirmed cases of CRBSI is 5 - 7 days for uncomplicated infections in most cases. A longer duration of antimicrobial therapy is advocated in the setting of *Staphylococcus aureus* or *Candida* species

infections. For coagulase-negative staphylococci (CoNS), removal of the catheter alone is often all that is required, with resolution occurring in the majority of cases post removal.

In conclusion, a simple new mnemonic – **CRBSI** – is proposed by the author, as a way of remembering and reinforcing the core elements of care pertaining to CVCs and as a means of limiting infective-related sequelae.

C - **c**hlorhexidine-alcohol skin antisepsis; **c**aps (port protectors)

R - **r**emove all unnecessary lines; **r**emain *in situ* for up to 14 days safely if required with appropriate infection control measures (longer durations may be possible but sound evidence exists for up to 14 days)

B - **b**arrier precautions to the maximum (sterile gloves, mask, gown, cap, large drape)

S - **s**ite **s**election (site probably makes very little difference if adequate infection control measures)

  - **s**eal and **s**ecurement: newer chlorhexidine containing dressings if possible

I - **i**mpeccable **i**nfection control (preparation, insertion, maintenance)

  - **i**mportance of hand hygiene at all times

  - **i**nspect daily (and record)

Adherence to these basic measures will go a long way in helping to achieve the ultimate goal of zero catheter-related infections.

Mervyn Mer, MBBCh, Dip PEC (SA), FCP (SA), Pulmonology subspecialty, Cert Critical Care (SA), MMed (Int Med), FRCP (London), FCCP, PhD

Department of Medicine, Divisions of Pulmonology and Critical Care, Charlotte Maxeke Johannesburg Academic Hospital and Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

mervyn.mer@wits.ac.za

1. Mer M. Intravascular catheter-related infection: update and overview. CME 2008;26(11):540-544.
2. iData Research. Central Venous Catheter Market Size, Share and Trends Analysis, Global 2020-2026. www.idataresearch.com/product/central-venous-catheter-market/. (accessed 21 February 2022).
3. Glover E, Abrahamson A, Adams J, et al. Central line-associated bloodstream infections at the Multidisciplinary Intensive Care Unit of Universitas Academic hospital, Bloemfontein. Afr J Thorac Crit Care Med 2022;28(1):15-19. https://doi.org/10.7196/AJTCCM.2022.v28i1.175
4. Rosenthal VD, Maki DG, Salamao R, et al. Device-associated nosocomial infections in 55 intensive care units of 8 developing countries. Ann Intern Med 2006;145(8):582-591. https://doi.org/10.7326/0003-4819-145-8-200610170-00007
5. Rosenthal VD, Bat-Erdene I, Gupta D, et al. International Nosocomial Infection Control Consortium (INICC) report, data and summary of 45 countries for 2012-2017: Device-associated module. Am J Infect Control 2020;48(4):423-432. https://doi.org/10.1016/j.ajic.2019.08.023
6. Rosenthal VD, Myatra SN, Divatia JV, et al. The impact of COVID-19 on healthcare-associated infections in intensive care units in low-and middle-income countries: International Nosocomial Infection Control Consortium (INICC) findings. Int J Infect Dis 2022;118:83-88. https://doi.org/10.1016/j.ijid.2022.02.041
7. Mimoz O, Lucet J-C, Kerforne T, et al. Skin antisepsis with chlorhexidine-alcohol versus povidone iodine-alcohol, with and without skin scrubbing, for prevention of intravascular-catheter-related infection (CLEAN): An open- label, multicentre, randomized, controlled, two-by-two factorial trial. Lancet 2015;386(10008):2069-2077. https://doi.org/10.1016/s0140-6736(15)00244-5
8. Pages J, Hazera P, Megarbane B, et al. Comparison of alcoholic chlorhexidine and povidone-iodine cutaneous antiseptics for the prevention of central venous catheter-related infection: A cohort and quasi-experimental multicenter study. Intensive Care Med 2016;42(9):1418-1426. https://doi.org/10.1007/s00134-016-4406-4
9. Mer M, Duse AG, Galpin JS, Richards GA. Central venous catheterization: A prospective randomized, double-blind study. Clin Appl Thromb Hemostat 2009;15(1):19-26. https://doi.org/10.1177/1076029608319878
10. Timsit J-F, Baleine J, Bernard L, et al. Expert consensus-based clinical practice guidelines management of intravascular catheters in the intensive care unit. Ann Intensive Care 2020;10(1):118. https://doi.org/10.1186/s13613-020-00713-4