



Getting Started Kit: Prevent Central Line Infections Bibliography

Safer Healthcare Now!

We invite you to join the *Safer Healthcare Now!* Campaign (SHN) to help improve the safety of our healthcare system in Canada. *Safer Healthcare Now!* is a campaign to enlist Canadian healthcare organizations in implementing six targeted interventions in patient care. The campaign is supported by the Institute for Healthcare Improvement (IHI) and is patterned after IHI's *100,000 Lives* Campaign. Further details, including materials, contact information and discussions are available at

<http://www.saferhealthcarenow.ca>

These kits, based on those originally developed by IHI for its *100,000 Lives* Campaign, are designed to engage your teams and clinicians in a dynamic approach for quality improvement, and to provide a thorough basis for *getting started*. **Please note that although the SHN kits and the original kits developed by IHI are similar, there are also key differences in the content of the interventions and corresponding measures for some kits.** These differences are clearly noted in the body of the SHN kits themselves, and on the SHN website.

The information in these "Getting Started" kits is based on the current state of knowledge. Consistent with the dynamic nature of this campaign, which continues to evolve, emerging evidence may influence adaptation of the kits in the future. We remain open to working consultatively on updating the content as together we make healthcare safer in Canada.

Acknowledgement

We wish to thank and acknowledge the Institute for Healthcare Improvement (IHI) for their significant support and contributions to the *Safer Healthcare Now!* Campaign (SHN).

The references included in this Bibliography are those contained in the bibliography for IHI's 100K Lives Campaign, with additional references identified by SHN.

BIBLIOGRAPHY – PREVENT CENTRAL LINE INFECTIONS

Berenholtz SM, Pronovost PJ, Lipsett PA, et al. Eliminating catheter-related bloodstream infections in the intensive care unit. *Crit Care Med.* Oct 2004;32(10):2014-2020.

Prospective cohort study involving all patients with a central venous catheter in a surgical ICU, in which a quality improvement team implemented five interventions: staff education, use of a catheter insertion cart, asking providers daily whether lines could be removed, implementing a checklist to ensure adherence to evidence-based guidelines, and empowering nurses to stop the catheter insertion procedure if a violation of the guidelines was observed. The rate of catheter-related bloodstream infections fell from 11.3 per 1,000 catheter-days to zero after implementation of these interventions.

Chaiyakunapruk N, Veenstra DL., Lipsky BA., Saint S. Chlorhexidine Compared with povidone-iodine solution for vascular catheter–site care: A meta-analysis. *Ann Intern Med.* 2002;136:792-801.

A meta-analysis of randomized clinical trials comparing any type of Chlorhexidine gluconate with povidine-iodine antiseptic solutions for vascular catheter site care. The primary outcome of interest was catheter related bloodstream infection which the authors defined as isolation of the same organism from a peripheral blood culture and a semiquantitative or quantitative culture of a catheter segment. The article summarizes data from 8 randomized trials. Their analysis demonstrated a risk ratio of 0.49 [95% CI, 0.28 to 0.88] when using Chlorhexidine antiseptic solutions.

Cobb DK, High KP, Sawyer RG, et al. A controlled trial of scheduled replacement of central venous and pulmonary-artery catheters. *N Engl J Med.* Oct 8 1992;327(15):1062-1068.

Controlled trial in adult ICU patients requiring central venous or pulmonary artery catheters for more than three days. Patients were randomized to replacement every three days by insertion at a new site, replacement every three days over a guide wire, replacement when clinically indicated at a new site, or replacement when clinically indicated over a guide wire. Guide wire exchange was associated with an increased risk of bloodstream infection. Reinsertion at a new site was associated with an increased risk of mechanical complications. Replacement at three days did not reduce the risk of infection.

Cook D, Randolph A, Kernerman P et al. Central venous catheter replacement strategies: a systematic review of the literature. *Crit Care Med* 1997;25:1417-24.

The authors conducted a quantitative systematic review to: a) compare guidewire exchange with new-site replacement with regard to the frequency of colonization, catheter exit site infection, catheter-related bacteremia, and mechanical complications; and b) compare scheduled catheter management with as-needed catheter management with regard to these outcomes. 12 relevant randomized studies were chosen from a pool of 151 randomized controlled trials on central venous catheter management. Catheter exchange over a wire was associated with a trend towards more infectious complications, although there was also a trend towards reduced mechanical complications with the use of guidewire exchange. The authors were unable to find any evidence to support routine replacement of catheters in order to reduce the incidence of catheter related bloodstream infections.

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Eggimien P, Sax H, Pittet D. Catheter-related infections. *Microbes and Infection* 2004;6:1033–1042.

A recent review describing the epidemiology, impact, pathogenesis and risk factors, treatment and prevention of catheter related blood stream infections.

Elward AM, Hollenbeak CS, Warren DK and Fraser VJ. Attributable Cost of Nosocomial Primary Bloodstream Infection in Pediatric Intensive Care Unit Patients. *Pediatrics* 2005;115:868-872.
<http://www.pediatrics.org/cgi/content/full/115/4/868>

This prospective cohort study looked at total and direct medical costs of PICU and hospital stay for patients with and without nosocomial primary BSI. The PICU studied had a high baseline rate of catheter related BSI of 13.8 per 1000 central venous line days. After controlling for age, severity of illness, underlying disease and ventilator days, the direct cost of PICU attributable for nosocomial primary BSI was estimated to be \$39,219USD. The savings through the elimination or reduction in these and other nosocomial infections are considerable.

Goetz AM, Wagener MM, Miller JM, Muder RR. Risk of infection due to central venous catheters: effect of site of placement and catheter type. *Infect Control Hosp Epidemiol.* 1998;19(11):842-845.

Prospective observational study of the risk factors for colonization of catheters and of catheter-related bloodstream infection over 28 months of all non-tunneled central venous catheters on medical-surgical wards of a VA hospital. Emergent insertion and choice of the femoral vein for insertion were associated with catheter contamination, and there was a trend for an association between femoral placement and catheter-related bloodstream infection.

Groeger JS, Lucas AB, Thaler HT, et al. Infectious morbidity associated with long-term use of venous access devices in patients with cancer. *Ann Intern Med.* 1993;119:1168.

A prospective observational study was conducted to evaluate infectious morbidity associated with long-term use of venous access devices. Quantitative microbiologic tests were used to identify device-related bacteremia and fungemia, catheter tunnel infection, pocket infection in implantable port devices, and site infections; number of days the device remained in situ and time until infectious morbidity; vessel or device thrombosis and device breakage. The incidence of infections per device-day was 12 times greater with catheters than with ports. Patients with solid tumors were the least likely to have device-related infectious morbidity compared with those with hematologic cancers. The authors speculate that the reasons for the difference in infectious complications is uncertain but may be attributable to type of disease, intensity of therapy, frequency with which devices are accessed, or duration of neutropenia.

Larson E. Skin hygiene and infection prevention: more of the same or different approaches? *Clin Infect Dis.* 1999;29(5):1287-1294.

Review of seven studies published between 1977 and 1995 that examined the relationship between handwashing and hospital-acquired infection. The review concluded that there was a clear causal relationship between hand hygiene and reduced transmission of infections. Recommended practices included use of waterless alcohol-based products rather than detergent-based antiseptics to reduce skin damage.

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Lautenbach E. **Error! Bookmark not defined.** Practices to Improve Handwashing Compliance. Chapter 12. IN: Agency for Healthcare Research and Quality. *Making Health Care Safer: A Critical Analysis of Patient Safety Practices*. 2001. pp. 119-126.

A detailed literature review, performed by the University of California at San Francisco (UCSF)-Stanford University Evidence-Based Practice Center, of published research on practices to improve handwashing compliance. The chapter starts with a brief review of the well-accepted evidence that handwashing is the most important single intervention to reduce transmission of infections in hospitals.

Maki DG, Alvarado CJ, Hassemer CA, Zilz MA. Relation of the inanimate hospital environment to endemic nosocomial infection. *N Engl J Med*. 1982;307(25):1562-1566.

A prospective study of the bacteria present in the physical environment in a 56-year-old hospital building which was then repeated when the University of Wisconsin moved into a new building complete with air filters, much improved ventilation, and isolation rooms with separate ventilation. Despite major differences in the environmental contamination between the two sites, the rate of hospital-acquired infection remained the same. There was a significant increase in environmental contamination after the new facility was occupied. These findings suggest that the organisms in the inanimate physical hospital environment are not a major contributor to infection – and that most infections are transmitted by hospital staff.

Maki DG. Infections due to infusion therapy. In: *Hospital Infections*, Third Edition, Bennett JV, Brachman PS (eds). Boston: Little, Brown, 1992.

Maki DG, Ringer M, Alvarado CJ. Prospective randomised trial of povidone-iodine, alcohol, and chlorhexidine for prevention of infection associated with central venous and arterial catheters. *Lancet*. 1991;338(8763):339-343.

Randomized controlled trial on a surgical ICU in which 668 catheters were placed with either 10% povidone-iodine, 70% alcohol, or 2% aqueous chlorhexidine disinfection of the site prior to insertion and every other day thereafter. Use of chlorhexidine was associated with the lowest risk of local and bloodstream catheter-related infections.

Massanari RM. Nosocomial infections in critical care units: causation and prevention. *Crit Care Nurs Q*. 1989;11(4):45-57.

Detailed narrative review of the causes and prevention of infections in ICUs, including the properties of specific bacteria that enable them to cause hospital-acquired infection, reservoirs of infection, patient-related factors, and the importance of handwashing, including a summary of several reports of epidemics of infection on ICUs.

McCarthy MC, Shives JK, Robison RJ, et al. Prospective evaluation of single and triple lumen catheters in total parenteral nutrition. *JPEN J Parenter Enteral Nutr*. 1987;11:259.

This prospective study was performed to examine the complications associated with the use of these catheters in patients receiving long-term total parenteral nutrition (TPN). The two groups were comparable with respect to concomitant infections, treatment with antibiotics, and need for intensive care. However, after five days of catheterization, there was a marked increase in the number of TLC removed because of skin entry site infections. SLC were more likely to be used for the full duration of TPN administration.

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Mermel LA, McCormick RD, Springman SR, Maki DG. The pathogenesis and epidemiology of catheter-related infection with pulmonary artery Swan-Ganz catheters: a prospective study utilizing molecular subtyping. *Am J Med.* 1991;91(3B):197S-205S.

Prospective observational study of Swan-Ganz catheters, showing that the great majority of infections come from the insertion site. Other risk factors were use of the jugular insertion site, duration of catheter dwell for more than three days, and lack of full barrier precautions during insertion.

Mermel LA. Prevention of intravascular catheter-related infections. *Ann Intern Med.* 2000;132(5):391-402.

Narrative review that summarizes data on the epidemiology, costs, attributable mortality, and prevention of bloodstream infections caused by ventral venous catheters.

Merrer J, De Jonghe B, Golliot F, et al. Complications of femoral and subclavian venous catheterization in critically ill patients: a randomized controlled trial. *JAMA.* 2001;286(6):700-707.

Randomized controlled trial in 289 adults requiring a first central venous catheter, randomized to femoral or subclavian site. The femoral site was associated with a higher risk of infectious and thrombotic complications.

O'Grady NP, Alexander M, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter-related infections. Centers for Disease Control and Prevention. *MMWR Recomm Rep.* Aug 9 2002;51(RR-10):1-29.

CDC guidelines for prevention of infection related to all types of intravascular catheter. Available at <http://www.cdc.gov/mmwr/PDF/RR/RR5110.pdf>

Parenti CM, Lederle FA, Impola CL, Peterson LR. Reduction of unnecessary intravenous catheter use. Internal medicine house staff participate in a successful quality improvement project. *Arch Intern Med.* 1994;154(16):1829-1832.

Quality improvement project led by medicine house staff in a large university-affiliated veterans hospital that resulted in a marked reduction in "idle catheter episodes," defined as periods when peripheral IV catheters were not being used.

Pittet D, Tarara D, Wenzel RP. Nosocomial bloodstream infection in critically ill patients. Excess length of stay, extra costs, and attributable mortality. *JAMA.* 1994;271(20):1598-1601.

Case-control study in a surgical ICU over two years. Patients who developed bloodstream infection during their ICU stay were matched for primary diagnosis, age, gender, length of stay up to the day of infection, and total number of discharge diagnoses with patients who did not develop bloodstream infection ("controls"). The mortality was 50% in patients who developed bloodstream infection compared to 15 amongst controls, giving an estimated attributable mortality of 35%. Of those who survived the bloodstream infection, median hospital stay was 45 days, compared to 30 days in controls. The extra cost attributed to the infection averaged \$40,000 per survivor.

Pittet D. Improving compliance with hand hygiene in hospitals. *Infect Control Hosp Epidemiol.* 2000;21(6):381-386.

Review of the reasons for poor compliance with handwashing amongst hospital staff. Easy access to handwashing facilities and ready availability of skincare lotion are imperative to ensure improved compliance. A multimodal, multidisciplinary approach at the individual, group, and institutional level is recommended.

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Raad, II, Hohn DC, Gilbreath BJ, et al. Prevention of central venous catheter-related infections by using maximal sterile barrier precautions during insertion. *Infect Control Hosp Epidemiol.* 1994; 15(4 Pt 1):231-238.

Randomized controlled trial of maximum barrier precautions vs. use of sterile gloves and small drape during insertion of non-tunnelled central venous catheters for cancer chemotherapy. Maximal barrier precautions markedly reduced the early infection rate.

Raad, II, Hanna HA. Intravascular catheter-related infections: new horizons and recent advances. *Arch Intern Med.* 2002; 162(8):871-878.

Narrative review of over 100 published articles on intravascular catheter-related infection, focusing on new diagnostic techniques, novel preventive techniques, and optimal management of infections.

Saint S. Chapter 16: Prevention of Intravascular Catheter-Associated Infections. IN: Agency for Healthcare Research and Quality. *Making Health Care Safer: A Critical Analysis of Patient Safety Practices.* 2001.

<http://www.ahrq.gov/clinic/evrptfiles.htm#ptsafety>.

A detailed literature review, performed by the University of California at San Francisco (UCSF)-Stanford University Evidence-Based Practice Center, of published research on prevention of intravascular catheter-associated infections, sponsored by AHRQ and published in July 2001.

Soufir L, Timsit JF, Mahe C, et al. Attributable morbidity and mortality of catheter-related septicemia in critically ill patients: a matched, risk-adjusted, cohort study. *Infect Control Hosp Epidemiol.* 1999; 20(6):396-401.

A matched, risk-adjusted cohort study to determine the attributable risk of death due to catheter-related septicemia (CRS) in critically ill patients when taking into account severity of illness during the ICU stay but before CRS. The study concludes that CRS is associated with subsequent morbidity and mortality in the ICU, even when adjusted on severity factors at ICU admission. However, after adjustment on severity factors during the ICU stay and before the event, there was only a trend toward CRS-attributable mortality. The authors conclude that the evolution of patient severity should be taken into account when evaluating excess mortality induced by nosocomial events in ICU patients.

Snydman DR, Murray SA, Kornfeld SJ, Majka JA, Ellis CA. Total parental nutrition-related infections: prospective epidemiologic study using semi-quantitative methods. *Am J Med* 1982; 73:695-9

This is a prospective study on TPN related infections in 100 consecutive adult patients receiving TPN using semi-quantitative culture methods. The only risk factor found to be associated with the development of nutrition related infection was violation of the nutrition line, such as CVP measurement and administration of medications.