Editorial

Understaffing: A Risk Factor for Infection in the Era of Downsizing?

Barry M. Farr, MD, MSc

Francis Bacon observed that "knowledge is power." There must be few uses of power more gratifying than to stop an epidemic of bloodstream infections, as demonstrated in the accompanying article by Fridkin et al.[1] Catheter-related bloodstream infections are particularly troublesome because of dramatic morbidity, a case fatality rate of 14%,[2] and their iatrogenic nature.

Detection of an epidemic of infection depends on the method of surveillance employed, as well as the definitions being used. Fridkin and colleagues make it clear that the rate they would have preferred to calculate was unavailable because of the lack of surveillance data regarding catheter days. For this reason, TPN days was used as a rough surrogate. It should also be noted that the diagnosis of catheter-related bloodstream infection using definitions employed by the National Nosocomial Infection Surveillance (NNIS) System,[3] as done in this study, may not be quite as rigorous as in research publications regarding catheter infections, as previously discussed by Maki.[4] The method of collecting blood cultures before and during the outbreak, for example, is not stated, perhaps because NNIS definitions do not make such distinctions. It remains possible that clinicians drew blood cultures more frequently from indwelling catheters during the outbreak, resulting in a higher rate of contamination.[4-6] It also is possible that clinicians became increasingly more disposed to treat when there was a single blood culture positive for a coagulase-negative *Staphylococcus.* A clinician's decision to treat would result in a diagnosis of bloodstream infection according to NNIS definitions, even if several other sets of simultaneous blood cultures were negative.[3] It is not stated whether the method employed for catheter segment cultures was the same as that recommended by Maki,[7] and, if so, why a CFU count >15 was not used (as recommended by Maki) rather than qualitative grading of microbial growth. If, however, we accept that the epidemic was due to valid bacteremias and not to overdiagnosis (employing Coleridge's "willing suspension of disbelief"), and that the epidemic extended for almost 2 years, then we must conclude that this was an important outbreak to understand and control.

Much knowledge has been gained about the epidemiology and prevention of catheter-related bloodstream infections over the past several decades that could be applied to reduce the rate of infections during an epidemic. Multiple studies have shown that much of the risk for infection of a central venous catheter relates to the manner of insertion of the catheter. Armstrong et al showed that the risk for significant colonization of the catheter (ie, $\geq$15 colony-forming units on semiquantitative culture of a catheter segment) was significantly related to the cumulative experience of the physician inserting the catheter.[8] The outbreak described by Fridkin et al occurred in a university-affiliated Veterans Affairs medical center, and, although there is no direct statement regarding the level of experience of those inserting the catheters, the reader would assume that

From the University of Virginia Health Sciences Center, Charlottesville, Virginia.
Address reprint requests to Barry Farr, MD, MSc, Department of Internal Medicine, University of Virginia Health Sciences Center, Box 473, Charlottesville, VA 22908.
95-ED-216. Farr BM. Understaffing: a risk factor for infection in the era of downsizing? Infect Control Hosp Epidemiol *1996;17:147-149.*

https://doi.org/10.1086/647261 Published online by Cambridge University Press

resident physicians may have placed some or all of the catheters. Mermel et al[9] and Raad et al[10] have shown that the use of sterile gowns and large drapes for inserting a central catheter, in addition to a mask and sterile gloves, results in significantly fewer infections than the older, "quicker and dirtier" approach that used only a mask, sterile gloves, and small drape. The exact method used for insertion during the outbreak is not stated in the article by Fridkin, leaving room for the reader to imagine that relatively inexperienced physicians could have been placing some catheters with less than the optimal technique described in the two studies cited above.

While it is clear that catheters can become contaminated or infected at the time of insertion, it also is clear that infection of the catheter can be related to subsequent care and management of the catheter. Use of total parenteral nutrition (TPN) catheters for purposes other than TPN has been associated with infection in a case-control study.[11] Forty percent of the catheters used for TPN for case-patients in the outbreak described by Fridkin et al reportedly had been used for dialysis or hemodynamic monitoring prior to their use for infusion of TPN. A randomized trial of the use of protective gown and glove isolation for patients in a pediatric intensive care unit showed a significantly lower overall rate of infection for those in isolation; the rate of primary bloodstream infection (0.3%) was lower for those in isolation than for the unisolated group (1.3%, P=.08), suggesting that interactions between clinicians and patients after insertion of the catheter may be important in causing bacteremia.[12] The findings of four studies that the use of a special intravenous (IV) team to care for TPN catheters resulted in lower infection rates also supports this view.[13-16] The failure to demonstrate an effect of having the IV team dress catheters in the present study could be due to hub contamination during infusion of medications or during blood drawing, as mentioned by the authors. It appears likely that some departure from optimal management of the TPN catheters was responsible for the excessive rate of infection, because three recent studies found no association between use of TPN and risk for catheter-related bloodstream infection, demonstrating that TPN is not necessarily associated with a high rate of infection.[17-19] It recently has been hypothesized that the adequacy of glucoregulation may have an important effect on the risk for bloodstream infection in patients receiving TPN.[20,21] Needleless tubing connections also have been linked to infection of TPN catheters in one recent outbreak.[22] Information on the adequacy of glucoregulation and the type of intravenous tubing connections used in the study by Fridkin et al was not provided.

Recent randomized trials have shown prevention of catheter-related bloodstream infections by application of povidone-iodine ointment to subclavian dialysis catheters[23] and by using cotton gauze rather than transparent dressings,[24] but other studies failed to support these findings.[25,26] Further studies of the effects of povidone-iodine ointment and of gauze versus transparent dressings will be needed to confirm their use. By contrast, the efficacy of prepping with chlorhexidine solution, as compared with either alcohol or povidone-iodine solution, has been demonstrated consistently,[27-29] and commercial availability of this antiseptic in the near future should be a high priority. A silver-impregnated cuff[30] and an antiseptic-impregnated catheter[31] both have been shown to prevent catheter-related bloodstream infections in randomized trials.

The authors acknowledge the small sample size and consequent large confidence intervals associated with some of the risk factors in their analysis. While these features make definitive conclusions impossible, their study does provide an important confirmation for a previous study by Haley and Bregman,[32] which found that understaffing was an important risk factor for epidemic staphylococcal infection in a neonatal special care unit in the early 1970s. This result is biologically plausible, given the data cited above showing that interactions between staff and patients after placement of a catheter can have an important influence on the risk for infection. It is possible that relaxation of aseptic technique due to understaffing could have resulted in contamination and consequent bloodstream infection. The use of povidone-iodine for disinfecting ports before vascular access in this hospital also could be relevant, in that the effect of alcohol is much faster than that of povidone-iodine, and an overworked nurse may not wait minutes for povidone-iodine to have its maximal effect.[33]

The results of the excellent analysis by Fridkin et al regarding the importance of understaffing as a risk factor for nosocomial infection are important to consider at a time when hospitals throughout the United States are steadily downsizing their work forces to cut costs and to allow for large reductions in patient charges. Further studies are needed evaluating the effects of staffing levels on quality of care. Such studies should focus on the rates of both infectious and noninfectious complications of care and the costs of poor quality of care.

REFERENCES

1. Fridkin SK, Pear SM, Williamson TH, Galgiani JN, Jarvis WR. The role of understaffing in central venous catheter-associated bloodstream infections. *Infect Control Hosp Epidemiol* 1996;17:150-157.

https://doi.org/10.1086/647261 Published online by Cambridge University Press

2. Byers KE, Adal KA, Anglim AM, Farr BM. Case fatality rate for catheter-related bloodstream infections (CRBSI): a meta-analysis. *Infect Control Hosp Epidemiol* 1995;16:P23. Abstract 43.
3. Garner JS, Jarvis WR, Emori TG, Horan TC, Hughes JM. CDC definitions for nosocomial infections, 1988. *Am J Infect Control* 1988;16:128-140.
4. Maki DG. Infections due to infusion therapy. In: Bennet JV, Brachman PS, ed. *Hospital Infections.* 2nd ed. Boston, MA: Little, Brown and Co; 1992:849-899.
5. Bates DW, Goldman K, Lee TH. Contaminant blood cultures and resource utilization. *JAMA* 1991;265:365.
6. Bryant JK, Stand CL. Reliability of blood cultures collected from intravascular catheter versus venipuncture. *Am J Clin Pathol* 1987;88:113-116.
7. Maki DG, Weise CE, Sarafin HW. A semiquantitative culture method for identifying intravenous-catheter-related infection. *N Engl J Med* 1977;296:1305-1309.
8. Armstrong CW, Mayhall CG, Miller KB, et al. Prospective study of catheter replacement and other risk factors of infection of hyperalimentation catheters. *J Infect Dis* 1986;154:808-816.
9. 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(suppl 3B):1975-2055.
10. 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;15:231-238.
11. Snydman DR, Murray SA, Kornfeld SJ, Majka JA, Ellis CA. Total parenteral nutrition related infections: prospective epidemiologic study using semiquantitative methods. *Am J Med* 1982;73:695-699.
12. Klein BS, Perloff WH, Maki DG. Reduction of nosocomial infection during pediatric intensive care by protective isolation. *N Engl J Med* 1989;320:1714-1721.
13. Faubion WC, Wesley JR, Khalidi N, Silva J. Total parenteral nutrition catheter sepsis: impact of the team approach. *JPEN* 1986;10:642-645.
14. Freeman JB, Lemire A, Maclean LD. Intravenous alimentation and septicemia. *Surg Gynecol Obstet* 1972;135:708-712.
15. Nehme AE. Nutritional support of the hospitalized patient. The team concept. *JAMA* 1980;243:1906-1908.
16. Nelson DB, Kien CL, Mohr B, Frank S, Davis SD. Dressing changes by specialized personnel reduce infection rates in patients receiving central venous parenteral nutrition. *JPEN* 1986;10:220-222.
17. 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* 1992;327:1062-1068.
18. Howell PB, Walters PE, Donowitz GR, Farr BM. Risk factors for infection of adult patients with cancer who have tunneled central venous catheters. *Cancer* 1995;75:1367-1375.
19. Maki DG, Stolz S. The epidemiology of central-venous catheter-related bloodstream infection (BSI). Programs and Abstracts of the 34th Interscience Conference of Antimicrobial Agents and Chemotherapy; Orlando, FL; 1994. Abstract J47.
20. Baxter JK, Babineau TJ, Apovian CM, et al. Perioperative glucose control predicts increased nosocomial infection in diabetics. *Crit Care Med* 1990;18(4):207.
21. Babineau TJ. TPN vs TEN decision analysis. In: *Malnutrition in the Hospitalized Patient.* Boston, MA: Harvard Medical School; 1995.
22. Danzig L, Short L, Collins K, et al. Bloodstream infections (BSIs) associated with a needleless intravenous (IV) infusion system used in patients on home infusion therapy. Programs and Abstracts of the 34th Interscience Conference of Antimicrobial Agents and Chemotherapy; Orlando, FL; 1994. Abstract J200.
23. Levin A, Mason AJ, Jindal KK, Fong IW, Goldstein MB. Prevention of hemodialysis subclavian vein catheter infections by topical povidone iodine. *Kidney Int* 1991;40:934-938.
24. Conly JM, Grieves K, Peters B. A prospective, randomized study comparing transparent and dry gauze dressings for central venous catheters. *J Infect Dis* 1989;159:310-319.
25. Maki DG, Stolz SM, Wheeler SJ, Mermel LA. A prospective, randomized trial of gauze and two polyurethane dressings for site care of pulmonary artery catheters: implications for catheter management. *Crit Care Med* 1994;22:1729-1737.
26. Prager RL, Silva J. Colonization of central venous catheters. *South Med J* 1984;77:458-461.
27. Maki DG, Ringer M, Alvarado CJ. Prospective randomized trial of povidone-iodine, alcohol, and chlorhexidine for prevention of infection associated with central venous and arterial catheters. *Lancet* 1991;338:339-343.
28. Mimoz O, Pieroni L, Lawrence C, Edouard A, Samii K. Prospective trial of povidone-iodine (PI) and chlorhexidine (CH) for prevention of catheter-related sepsis (CRS). Programs and Abstracts of the 34th Interscience Conference of Antimicrobial Agents and Chemotherapy; Orlando, FL; 1994. Abstract J56.
29. Sheehan G, Leicht K, O'Brien M, Taylor G, Rennie R. Chlorhexidine versus povidone-iodine as cutaneous antisepsis for prevention of vascular-catheter infection. Programs and Abstracts of the 33rd Interscience Conference of Antimicrobial Agents and Chemotherapy; New Orleans, LA; 1993. Abstract 1616.
30. Flowers RH, Schwenzer KJ, Kopel RF, Fisch MJ, Tucker SI, Farr BM. Efficacy of an attachable subcutaneous cuff for the prevention of intravascular catheter-related infection: a randomized, controlled trial. *JAMA* 1989;216:878-883.
31. Maki DG, Wheeler SJ, Stolz SM, Mermel LA. Clinical trial of a novel antiseptic central venous catheter. Programs and Abstracts of the 31st Interscience Conference of Antimicrobial Agents and Chemotherapy. Chicago, IL; 1991. Abstract #461.
32. Haley RW, Bregman DA. The role of understaffing and overcrowding in recurrent outbreaks of staphylococcal infections in a neonatal special-care unit. *J Infect Dis* 1982;145:875-885.
33. Fauerbach LL, Schoppman MJ, Singh VR, Netardus LS, Pickett DL, Shands JW. A comparison of the efficacy of different antiseptics for intravascular site preparation. Programs and Abstracts of the 31st Interscience Conference of Antimicrobial Agents and Chemotherapy; Chicago, IL: 1991. Abstract 1269.

https://doi.org/10.1086/647261 Published online by Cambridge University Press