2006

Preventing catheter-associated bloodstream infections: A survey of policies for insertion and care of central venous catheters from hospitals in the prevention epicenter program

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Reviewed work(s):
Source: *Infection Control and Hospital Epidemiology*, Vol. 27, No. 1 (January 2006), pp. 8-13
Published by: The University of Chicago Press on behalf of The Society for Healthcare Epidemiology of America
Stable URL: http://www.jstor.org/stable/10.1086/499151
Accessed: 15/04/2012 18:32

ORIGINAL ARTICLE

Preventing Catheter-Associated Bloodstream Infections: A Survey of Policies for Insertion and Care of Central Venous Catheters From Hospitals in the Prevention Epicenter Program

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OBJECTIVE. To determine the extent to which evidence-based practices for the prevention of central venous catheter (CVC)–associated bloodstream infections are incorporated into the policies and practices of academic intensive care units (ICUs) in the United States and to determine variations in the policies on CVC insertion, use, and care.

DESIGN. A 9-page written survey of practices and policies for nontunneled CVC insertion and care.

SETTING. ICUs in 10 academic tertiary-care hospitals.

PARTICIPANTS. ICU medical directors and nurse managers.

RESULTS. Twenty-five ICUs were surveyed (1-6 ICUs per hospital). In 80% of the units, 5 separate groups of clinicians inserted 24%-50% of all nontunneled CVCs. In 56% of the units, placement of more than two-thirds of nontunneled CVCs was performed in a single location in the hospital. Twenty units (80%) had written policies for CVC insertion. Twenty-eight percent of units had a policy requiring maximal sterile-barrier precautions when CVCs were placed, and 52% of the units had formal educational programs with regard to CVC insertion. Eighty percent of the units had a policy requiring staff to perform hand hygiene before inserting CVCs, but only 36% and 60% of the units required hand hygiene before accessing a CVC and treating the exit site, respectively.

CONCLUSION. ICU policy regarding the insertion and care of CVCs varies considerably from hospital to hospital. ICUs may be able to improve patient outcome if evidence-based guidelines for CVC insertion and care are implemented.

Infect Control Hosp Epidemiol 2006; 27:8-13

Catheter-associated bloodstream infection is a common nosocomial infection among patients in the intensive care unit (ICU)[1] and has been estimated to occur in 3%-7% of all patients with central venous catheters (CVCs),[2] resulting in approximately 80,000 bloodstream infections annually in ICUs in the United States.[3] Because short-term venous access is often required in the treatment of critically ill patients, nontunneled CVCs are the most frequently used catheters in ICUs. Despite their short-term use, these catheters are associated with a higher rate of infection than tunneled catheters and totally implanted port catheter systems.[4]

Several studies have identified practices that reduce the risk of nosocomial bloodstream infection associated with CVC use. These practices include using maximal sterile-barrier precautions (ie, surgical masks, sterile gowns, sterile gloves, and large drapes) during catheter insertion,[5,6] accessing the subclavian vein rather than the internal jugular vein or femoral vein,[7,8] exchanging CVCs only when necessary,[9,10] and changing dressings at catheter exit sites when they become nonocclusive, soiled, or bloody.[11,12]

The extent to which hospitals have adopted evidence-based practices for preventing intravascular device–related nosocomial infection is not known. In a survey of nurses who perform vascular-access procedures, 87% of the respondents from teaching hospitals reported using sterile technique during dressing changes.[13] In a survey involving British ICUs, 52% of responding units endorsed a policy of routinely exchanging nontunneled CVCs,[14] despite data suggesting that this practice does not reduce the risk of catheter-associated bloodstream infection and increases the risk of procedure-related complications.[7] These reports suggest that healthcare facilities have incompletely adopted evidence-based practices for preventing catheter-associated bloodstream infection.

The purpose of our study was to survey staff in ICUs at

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Received April 8, 2005; accepted August 23, 2005; electronically published January 6, 2006.

multiple academic medical centers to identify the actual practices associated with insertion, use, and care of nontunneled CVCs and to review the written policies that specify how these procedures should be performed. We sought to determine the extent of variability in these practices, policies, and procedures and to compare the units' practices and policies with reports in published evidence-based studies.

METHODS

During April 2002, a 9-page survey of practices and policies for nontunneled CVC insertion and site care was distributed to ICUs housing adults at 10 hospitals associated with the Prevention Epicenter Program, a collaborative research project funded by the Centers for Disease Control and Prevention to investigate the epidemiology and prevention of healthcare-acquired infections. The participating hospitals were academic tertiary-care centers of varying size (mean number of beds, 775 [range, 427-1385 beds]). These units were chosen for the survey to aid in devising an intervention to reduce the incidence of catheter-associated bloodstream infection. Policies and practices for both peripherally inserted central catheters and nontunneled CVCs were included in our survey. The unit policies and practices concerning tunneled CVCs, totally implanted port catheter systems, and hemodialysis catheters were excluded from the study. Units with policies updated them at least every 2 years. The survey was reviewed for clarity and pilot tested by staff at nonparticipating ICUs.

The survey consisted of 3 sections. The first section comprised questions about ICU characteristics, including type of unit, staff composition, and number of beds. The second section inquired about the practices for insertion, use, and care of nontunneled CVCs and the formal education received by physicians and nurses concerning insertion, use, and care. This section included the question "Is it this unit's practice to change catheters routinely (eg, to prevent infections)?" and, for respondents who answered "Yes," a follow-up question concerning the interval between catheter exchanges. Formal education was defined as receipt of $\geqslant$0.5 hours of instruction devoted to the topics of CVC insertion, use, and care. Teaching received incidentally during rounds or patient care was excluded from consideration. This section also included questions about which clinicians inserted catheters and the hospital location where catheter insertion was performed.

Nurses and physicians familiar with the daily practices of the staff in the ICU answered the questions in the first and second sections of the survey. We interviewed nurse managers considered by the investigator to be able to comment on general practices regarding CVC insertion that were normally observed while assisting with this procedure. The survey was distributed to the study units during face-to-face meetings with unit staff. Participation in the survey was voluntary, and participation was considered to imply informed consent in all but one of the hospitals. The institutional review board of that hospital required the investigators to get written informed consent from the nurses and physicians before they could participate in the survey.

The third section of the survey was completed by one of the authors (D.K.W.), who reviewed all written policies reported by the participating units and abstracted recommendations on CVC insertion, use, and care from the written policies by use of a standardized data collection tool. Both infection-control directors and ICU directors were queried for hospital and unit-specific policies regarding CVCs, to ensure that all policies were identified. In all units studied, these policies were intended to apply to nursing staff and physician staff. For example, study personnel determined whether the policies recommended or required that catheters be inserted at specific anatomic sites, that catheters should be exchanged or changed at specific intervals, that a single lumen should be used for administration of total parenteral nutrition, and that catheter dressings be changed at specific intervals.

For the purposes of the survey, an ICU was defined as having a closed-staff model, if a dedicated team of physicians was responsible for patient care in the unit; an open-staff model, if physicians cared for patients in the unit and in other areas of the hospital; and a mixed-staff model, if a combination of the physician teams existed. Maximal sterile-barrier precautions for CVC insertion required the inserter to wear a hat, mask, sterile gown, and sterile gloves and to use large sterile drapes surrounding the catheter insertion site.[15]

Survey responses from each center were collected and entered into an Access database (Microsoft). Response frequencies were analyzed using SPSS, version 11.0 (SPSS). The institutional review boards at each study site and the Centers for Disease Control and Prevention approved this study.

RESULTS

Twenty-five (57%) of 44 available ICUs participated in the survey; 1-6 units were present in each hospital. Units that participated in the survey were similar to those that did not with respect to number of beds (median number, 12 vs 10 beds; $P = .19$), nurse-to-patient ratio (median ratio, 1 : 1.5 vs 1 : 15; $P = .41$), and staff model (60% open-staff vs 63% closed-staff; $P = .60$). Eleven medical directors and 17 nurse managers or assistant nurse managers provided information about practices in the ICU (in 3 units, both the medical director and nurse manager contributed information). The types of ICUs surveyed included 7 medical units (28%), 7 surgical units (28%), 3 coronary care units (12%), 3 cardiothoracic surgical units (12%), 2 combined neurological and neurosurgical units (8%), 2 combined medical and surgical units (8%), and 1 combined bone marrow and stem cell transplantation unit (4%). The survey units had a median of 12 beds (range, 8-30 beds). Fifteen (60%) of the units had a closed-staff model for physicians, 2 (8%) had an open-staff model, and the remaining 8 (32%) had a mixed-staff model.

CVC insertion: training, policies, and practices. Nursing

TABLE 1. Categories of Hospital Personnel Reported to Perform Nontunneled Central Venous Catheter (CVC) Insertion, by Percentage of CVCs Placed

	No. of ICUs Reporting, by Percentage of CVCs Placed				
Category of Personnel	0%	1%-24%	25%-49%	50%-75%	76%-100%
Nurse practitioner	23	0	2	0	0
Physician assistant	24	1	0	0	0
Intern	10	9	4	2	0
Resident	2	3	8	7	5
Fellow	4	15	5	0	1
Teaching attending physician	9	13	1	2	0
Private attending physician	23	2	0	0	0
Hospitalist or intensivist	18	7	0	0	0
Other[a]	22	2	0	0	1

NOTE. ICU = intensive care unit.

[a] Intravenous therapy nurses who inserted <25% of CVCs (exclusively peripherally inserted CVCs) in 2 of 17 units and interventional radiologists who inserted >75% of catheters in a single unit.

and medical staff who responded to the survey noted that, in 20 units (80%), 5 separate groups of clinicians (ie, nurse practitioners, interns, residents, fellows, and teaching attending physicians) inserted 24%-50% of all nontunneled catheters (Table 1). In 14 (56%) of the ICUs, more than two-thirds of nontunneled CVCs were inserted at a single location in the hospital (Table 2). Nine ICUs (36%) had a procedure cart that included supplies for CVC insertion, and 24 had central catheter insertion kits. Only 5 ICUs (20%) included large sterile drapes with insertion kits.

Thirteen ICUs (52%) reported providing formal education about CVC insertion to physicians. Techniques used to educate physicians included didactic lectures (52% of cases), hands-on training with mannequins (12%), self-study modules (12%), and Internet-based programs (4%). Six (46%) of the 13 ICUs that provided formal educational programs reported using >1 educational method.

Twenty ICUs (80%) had a written policy regarding CVC insertion (Table 3). All 20 ICUs with written policies required some form of sterile-barrier precautions during CVC insertion, and these insertion policies were uniform in their requirement of maximal sterile-barrier precautions, regardless of the anatomic insertion site. Only 7 units (28%) required all 5 components of maximum sterile-barrier precautions. Of the remaining units, 10 (40%) recommended or required 4 components, 3 (12%) required 2 or 3 components, and 5 (20%) had no policy about this aspect of sterile technique. Only 4 (29%) of the 14 ICUs that used povidone-iodine for skin preparation had policies recommending that the duration of skin contact be $\geqslant$3 minutes before catheter insertion.

The 20 ICUs with a policy about CVC insertion also had policies regarding the removal and/or exchange of catheters. Seven ICUs (28%) permitted the exchange of catheters over a guide wire when a catheter-associated infection was suspected, without stating whether the catheters should be removed if infection was confirmed. One ICU had a written policy that required exchange of nontunneled CVCs every 6 weeks to prevent infection. Interviews of unit personnel about actual practice revealed that 5 ICUs (25%) routinely exchanged CVCs. However, the duration a catheter could remain in place varied from 4 days to 6 weeks.

CVC use and care: training, policies, and practices. ICU staff nurses were responsible for the routine use and care of nontunneled CVCs. Formal education for nursing staff about the care and use of CVCs was provided in 22 (88%) of the ICUs surveyed. This education consisted of self-study ma-

TABLE 2. Hospital Locations Where Nontunneled Central Venous Catheter (CVC) Insertion Was Reported to Be Performed

	No. of ICUs Reporting, by Percentage of CVCs Placed				
Hospital Location	0%	1%-24%	25%-49%	50%-75%	76%-100%
Study unit	0	4	4	7	10
Operating room	8	9	4	1	3
Radiology unit	11	13	0	0	1
Emergency department	8	15	2	0	0
Other unit[a]	18	5	2	0	0

NOTE. ICU = intensive care unit.

[a] CVC insertion for patients in 5 units was performed in another unit <25% of the time, and CVC insertion for patients in 2 units was performed in the cardiac catheterization laboratory 25%-49% of the time.

TABLE 3. Nontunneled Central Venous Catheter (CVC) Insertion Practices Specified in the Written Policies of 25 Intensive Care Units (ICUs)

Written Policy Component	No. (%) of ICUs
Any written policy for CVC insertion	20 (80)
Preferred CVC insertion site	9 (36)
Subclavian vein[a]	6 (24)
Internal jugular vein	0
Femoral vein	0
Either subclavian or internal jugular veins	3 (12)
Sterile-barrier precaution to use[b]	20 (80)
Mask	20 (80)
Sterile gloves	19 (76)
Sterile gown	18 (72)
Large sterile drapes	8 (32)
Smaller sterile drapes	10 (40)
Maximal sterile-barrier precautions[a,c]	7 (28)
Skin preparation to use at CVC site[b]	20 (80)
Povidone-iodine[a]	14 (56)
Tincture of iodine[a]	9 (36)
Chlorhexidine	2 (8)
Chlorhexidine tincture	0
Other skin preparation (alcohol and alcohol-acetone)	4 (16)
Hand hygiene preparation to use[a,b]	20 (80)
Antibacterial soap	16 (64)
Alcohol foam or gel	10 (40)
Chlorhexidine	3 (12)
Povidone-iodine	1 (4)

[a] Centers for Disease Control and Prevention–Healthcare Infection Control Practices Advisory Committee recommendation at the time of the survey (no hand hygiene product was specified in the guidelines).[15]
[b] Some policies allowed for the use of more than one of the items.
[c] Defined as the use of large sterile drapes, hat, mask, sterile gown, and sterile gloves.

terial (76% of cases), didactic sessions (60%), practice on mannequins (16%), and Internet-based programs (4%). The frequency of formal training for nursing staff varied between units, with 12 (48%) performing training annually, 9 (36%) providing training only during orientation, and 1 (4%) providing training only when a new product or procedure was introduced. All ICUs surveyed had a written policy about the use and care of nontunneled CVCs (Table 4). One unit discouraged use of the catheters' lumens for routine phlebotomy. None of the units surveyed had policies that specified indications for using antimicrobial-impregnated CVCs.

DISCUSSION

This survey of ICU policies and practices concerning the insertion, use, and care of nontunneled CVCs in hospitals participating in the Prevention Epicenter Program of the Centers for Disease Control and Prevention revealed that practices and policies varied substantially from one participating center to the next. This variation was most apparent in the practice of catheter insertion. As might be expected in a sample of predominantly academic medical centers, interns, residents, and fellows inserted most of the nontunneled CVCs needed by patients in the ICUs. However, in every unit surveyed, at least 2 different groups of clinicians inserted catheters. The hospital site where the insertion procedures occurred also varied substantially by center; 2 units reported that 25%-50% of their nontunneled catheters were inserted in the emergency department, and another unit reported that >75% of the catheters were placed in the radiology department.

One-fifth of the units did not have written policies about catheter insertion. We hypothesized, but could not prove, that the some of the units did not have policies for the insertion of CVCs either because several different groups of clinicians placed the catheters and therefore we concluded that no one took the responsibility to write a policy or because physicians, compared with nurses as a group, are less likely to write policies about procedures they performed.

TABLE 4. Nontunneled Central Venous Catheter (CVC) Use and Care Practice Specified in the Written Policies of 25 Intensive Care Units (ICUs)

Written Policy Component	No. (%) of ICUs
Dedicated lumen should be used for TPN[a]	23 (92)
Type of glove to use for accessing CVC lumen	22 (88)
Sterile	1 (4)
Nonsterile	16 (64)
Either	2 (8)
Hand hygiene preparation to use before accessing CVC[a,b]	9 (36)
Antibacterial soap	7 (28)
Alcohol foam or gel	1 (4)
Chlorhexidine	2 (8)
Indication for changing dressings at insertion sites	25 (100)
Dressing visibly soiled[a]	23 (92)
Nonocclusive or falling off[a]	25 (100)
Interval between routine dressing changes	25 (100)
2 days	3 (12)
3-4 days	4 (16)
7 days	12 (48)
Other[c]	4 (16)
Skin preparation to use for dressing change[b]	21 (84)
Chlorhexidine scrub	3 (12)
Chlorhexidine tincture	3 (12)
Providine-iodine[a]	13 (52)
Tincture of iodine[a]	9 (36)
Alcohol-acetone	1 (4)
Hand hygiene preparation to use before dressing change[a,b]	15 (60)
Antibacterial soap	9 (36)
Alcohol foam or gel	5 (20)
Chlorhexidine	2 (8)

NOTE. TPN = total parenteral nutrition.
[a] Centers for Disease Control and Prevention–Healthcare Infection Control Practices Advisory Committee recommendation at the time of the survey (no hand hygiene product was specified in guidelines).[15]
[b] Some policies allowed for the use of more than one of the items.
[c] Four units in a single hospital recommended that dressings be changed within the first 24 hours after the catheter was placed and at 6-day intervals thereafter.

Our data indicated that few ICUs had policies that complied with the 1996 Centers for Disease Control and Prevention–Healthcare Infection Control Practices Advisory Committee guideline for prevention of intravascular device–related infection,[15] which was the most current guideline at the time of the survey (these guidelines were updated in 2002[16]). Only 9 (36%) of the units surveyed specified the subclavian vein as a preferred anatomic site for CVC insertion. Only 7 (28%) of the units required that maximal sterile-barrier precautions be used during insertion of nontunneled CVCs. Even if the definition was broadened to include the use of smaller sterile drapes, only 68% of the units required sterile drapes that met this less stringent definition. Moreover, 1 ICU had a formal policy that catheters be exchanged routinely as a means of preventing infection. Three ICUs did not have formal policies about this topic, but staff in these units routinely exchanged catheters, although the frequency of exchange was highly variable. Thus, 16% of the units ignored data from randomized, controlled trials documenting that routine exchange of CVCs does not prevent catheter-associated infections but actually increases the risk of mechanical complications.[9,10] Despite evidence that bacteria can migrate from the skin to the bloodstream through the subcutaneous portion of the catheter,[6,17] an even greater proportion (28%) of the units had policies that permitted CVCs to be exchanged over guide wires if catheter-related infection was suspected without comments on removal of the new catheter if infection was subsequently found.

Every ICU that we surveyed had a written policy for catheter use and care. These policies tended to focus primarily on indications and procedures for changing dressings covering the catheter insertion site that are typically associated with nursing care. Interestingly, a substantial proportion of ICU policies did not require that staff perform hand hygiene before they touched a CVC or changed the catheter dressing. We are not sure why such an important component of aseptic technique was missing from these policies. The most optimistic possible explanation is that the authors of the policies believed that hand hygiene was such an obvious precursor to touching a CVC that they neglected to mention it in the policies. However, studies in ICUs have shown that personnel perform hand hygiene on only 22%-40% of the occasions at which it is indicated for each episode of patient contact.[18,19] Thus, we doubt that this possible explanation is correct.

This study had several limitations. We obtained a 57% participation rate in the 10 hospitals surveyed. In 6 of the hospitals, all ICUs participated, but 28%-40% of units in the other 4 hospitals took part in the survey. The hospitals with 100% participation were the "primary" hospital for one of the Prevention Epicenter Program investigators. The small sample size may limit the generalizability of this study. Also of note, only hospitals that are associated with the Prevention Epicenter Program were surveyed. We do not know whether this sample is representative of ICUs in other academic hospitals or of units in other types of hospitals. The most recent comprehensive survey of ICUs in the United States was performed more than a decade ago, and its findings may not reflect current characteristics.[20] Compared with ICUs described in that study, units in our study were from hospitals that were more likely to be large and academic; however, among hospitals with >500 beds, the mean ICU size and distribution of unit type were similar. We also wonder whether hospitals that are not members of the Prevention Epicenter Program have policies and practices that are better than those in centers that actively study the epidemiology and prevention of nosocomial infections. Another limitation is that we interviewed ICU staff to identify the typical practices regarding the insertion, use, and care of CVCs, and we reviewed written policies rather than observing actual practices. We do not know how well these policies correlated with actual practices, but we do know that self-reports of infection-control practices are often inaccurate.[21]

There are numerous reasons why physicians generally do not follow evidence-based guidelines. These include lack of awareness that a guideline for the particular subject even exists, lack of familiarity with the guideline's content, lack of self-efficacy, or lack of agreement with the guideline.[22,23] Few studies have systematically analyzed the infection-control policies adopted by ICUs and compared the policies with published evidence-based practices. Rello et al.[24] assessed whether critical-care physicians accepted evidence-based recommendations for prevention of ventilator-associated pneumonia. These investigators found that the physicians did not adhere to 37% of the recommendations. The investigators also found that adoption of a particular recommendation by a physician was dependent on whether the physician agreed with results of previous studies and whether the resources necessary to comply with the recommendation were available, rather than on the strength of scientific evidence for that recommendation.

Our ability to prevent catheter-associated bloodstream infections is dependent, to a large extent, on whether we can change the attitudes and behaviors of the staff who insert, use, and care for CVCs. This study demonstrates that hospitals in the Prevention Epicenter Program have not completely integrated published, evidence-based guidelines into their policies and practices. Given that different groups of clinicians insert these catheters and that catheters are often inserted in >1 location in the hospital, educational programs designed for this purpose must include a wide variety of clinicians and be done in several locations. In addition, because new residents and new nurses join the staff every year, the educational process must be continuous to be effective. We believe that staff in ICUs and infection-control programs who wish to decrease the risk of catheter-associated bloodstream infections should review their policies and actual practices as a first step. Since this survey was conducted, the participating hospitals and ICUs have, through joint efforts between infection control and ICU leadership, revised their policies to reflect current evidence-based guidelines. In ad-

dition, 13 of the ICUs studied are participating in a multicenter study of interventions to prevent catheter-associated bloodstream infections, in which techniques found to be successful in studies at several of the participating centers are being evaluated.[25,26] Our study demonstrates that communication and collaboration between infection-control staff and unit physicians and nurses is critical if changes in the ICU environment are to occur that reduce the risk of these serious device-related infections.

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Financial support for this study was provided by the CDC's Prevention Epicenter Program (UR8/CCU715087-03-CDC, UR8/CCU715091, UR8/CCU215090, UR8/CCU15081, UR8/CCU115079, UR8/CCU315092, and UR8/CCU315346) and the National Institutes of Health Career Development Award (K23 AI050585-01A1; to Dr. Warren).

ACKNOWLEDGMENTS

Additional members of the Prevention Epicenter Program at the Centers for Disease Control and Prevention (CDC) who played an integral role in this study include Osamudiamen Osa-Edoh, MBBS (Washington University School of Medicine); Sara E. Cosgrove, MD (Johns Hopkins School of Hygiene and Public Health); Daniel J. Diekema, MD (University of Iowa College of Medicine); Edward S. Wong, MD (Hunter Holmes McGuire Veterans Affairs Medical Center); Susan M. Cunningham, RN (Northwestern University Medical School); Theresa Plaskett, MPH, and Kent A. Sepkowitz, MD (Memorial Sloan-Kettering Cancer Center); and Steven L. Solomon, MD (CDC). We also gratefully acknowledge the contributions made by the physicians and nurses who willingly participated in this survey; Ms. Cherie Hill, for her assistance in data management; and Dr. Margaret Olsen, for her critical review of the manuscript.

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