basis of whether a hospital was listed as an approved program on the AAMC or ACGME websites. This resulted in some improvement in our risk-stratified list of hospitals but still presented anomalies. A deeper look at the AAMC and ACGME websites showed that the administrative home of each medical teaching program is not necessarily the only hospital where time is spent during training and that the amount of time spent in different places is reported by training site. That enabled us to test a more refined variable, which revealed misclassifications in both directions on the self-reported NHSN teaching status claim.

We recommend that NHSN adopt a more objective approach to defining hospital teaching status. Some hospitals have extensive involvement in a single teaching program, often a family practice residency program; the influence on case-mix of type of specialty as well as extent of time also should be investigated further.

ACKNOWLEDGMENTS

Financial support. This study was supported, in part, by an appointment to the Applied Epidemiology Fellowship Program administered by the Council of State and Territorial Epidemiologists (CSTE) and funded by the Centers for Disease Control and Prevention (CDC) Cooperative Agreement Number 1U38HM000414.

Potential conflicts of interest. Both authors report no conflicts of interest relevant to this article.

Roxie Zarate, MPH; David Birnbaum, PhD, MPH

From the Washington State Health Department, Olympia.

Address reprint requests to David Birnbaum, PhD, MPH, Washington State Department of Health, Healthcare-Associated Infections Program, PO Box 47811, Olympia, WA 98504-7811 (david.birnbaum@doh.wa.gov).

Infect Control Hosp Epidemiol 2010; 31(12):1310-1311

 0899-823X/2010/3112-0021$15.00. DOI: 10.1086/657585

REFERENCES

1. Sackett DL. Bias in analytic research. *J Chronic Dis* 1979;32:51–63.
2. Banerjee SN, Emori TG, Culver DH, et al. Secular trends in nosocomial primary bloodstream infections in the United States, 1980–1989. National Nosocomial Infections Surveillance System. *Am J Med* 1991;91(3B):86S–89S.
3. Centers for Medicare and Medicaid Services. Case mix index. http://www.cms.gov/acuteinpatientpps/ffd/ItemDetail.asp?ItemID=CMS022523. Modified September 8, 2005. Accessed June 30 , 2010.
4. Association of American Medical Colleges (AAMC). Member institution listings. http://services.aamc.org/memberlistings/index.cfm?fuseaction=home.search&search_type=TH&state_criteria=ALL Updated 2010. Accessed June 30, 2010.
5. Accreditation Council for Graduate Medical Education (ACGME). http://www.acgme.org/adspublic/default.asp. Accessed June 30, 2010.
6. Norman GR, Steiner DL. *Biostatistics: The Bare Essentials.* 2nd ed. Hamilton, Ontario: BC Decker; 2000.
7. Schifman RB, Howanitz PJ. Nosocomial infections: a College of American Pathologists Q-Probes Study in 512 North American institutions. *Arch Pathol Lab Med* 1994;118:115–119.
8. Christenson M, Hitt JA, Abbott G, et al. Improving patient safety: resource availability and application for reducing the incidence of healthcare-associated infection. Infect Control Hosp Epidemiol 2006;27(3):245–251.

Evaluation of the Flush Characteristics of 2 Peripheral Vascular Catheters

To the Editor—Peripheral vascular access is almost universal in current institutional health care, but devices intended for this purpose have risks associated with their use. Microorganisms can be introduced into these devices at insertion or during use, and once in the fluid path of these devices, they can grow to high numbers and be potentially life threatening. Although peripheral vascular catheters are not associated with the same risk for catheter-related bloodstream infection as central venous catheters, a recent review of the topic estimated a rate of 0.5 infections per 1,000 peripheral vascular catheter–days.[1]

Recently a peripheral vascular catheter with an internal valve (Z5; Medikit) was developed to limit healthcare worker exposure to blood. In this study, we compared the Z5 catheter to one without a valve (Insyte Autoguard [IAG]; Becton Dickinson). We found that the device with the integral backflow valve had higher numbers of bacteria recovered than the device without the blood control valve.

Staphylococcus epidermidis (ATCC 12228) was inoculated into trypticase soy broth and incubated at 35°C for 24 hours. Broth culture turbidity was adjusted to a 0.5 McFarland standard (approximately 1×10^8 colony forming units [CFU]/mL), and dilutions of this suspension were made in sterile water to give concentrations of approximately 1×10^3, 1×10^4, 1×10^5, and 1×10^6 CFU/mL. The control consisted of sterile water without microorganisms. Organism concentrations were confirmed by quantitative culture. Ten devices were tested in each group for each bacterial concentration.

Sterile, defibrinated sheep blood (Hemostat Laboratories) was added to a sterile syringe barrel attached to latex tubing. The other end of the tubing was attached to a 3-way stopcock to control the filling of the tubing. This simulated blood vessel was maintained at a positive pressure similar to venous pressure in a patient (10–15 mm Hg, or 13.7–20.3 cm of blood) by elevating the blood-filled syringe barrel approximately 17.8 cm above the blood draw site on the tubing.

Each catheter was then inserted into the tubing, the cannula was removed, and the device was allowed to fill with sheep blood until it was stopped by the valve (Z5) or until blood flowed from the back of the device (IAG). Each catheter was then removed from the simulated vein, and a needleless connector (Q-Syte; Becton Dickinson) was attached. For each catheter, a syringe containing 10 mL of the designated bacterial cell suspension was attached to the needleless connector. Over a period of 20 seconds, the bacterial suspension was

injected at a constant flow rate. The syringe was removed from the connector, and a Posi-Flush syringe (Becton Dickinson) was attached. Each device was flushed with 10 mL of physiological saline with a pulsatile flow technique (injecting 0.5 mL of saline 20 times with a total duration of 10 seconds). The devices were then locked with physiological saline, placed into sterile Petri plates, and incubated at 35°C for 24 hours.

Next, the devices were flushed using 1.0 mL of sterile saline 5 times to attempt to remove the residual blood and bacteria from the test set-up. Two serial 10-fold dilutions were made from each saline flush (0.1 mL plus 0.9 mL sterile saline), which were cultured on trypticase soy agar with sheep blood to determine the number of bacteria in each sample.

As shown in Table 1, there was no difference between the number of bacteria recovered from the 2 groups of devices when flushed with 10 mL of a low concentration of bacteria (approximately 147 CFU/mL). For devices inoculated with 1,600–523,000 CFU/mL of *S. epidermidis*, the IAG product had fewer bacteria recovered than the Z5 catheter with the blood control valve.

This study showed differences between 2 catheter types, one with a blood control valve and one without such a valve. The number of microorganisms present in a device is probably influenced by multiple factors, such as the initial number of bacteria remaining in the device, the presence or absence of a permissive environment (eg, nutrient-rich diluted blood), and the internal volume of the device. Blood remaining in the catheter hub may allow bacteria to grow to very high numbers in these devices, potentially predisposing to the development of catheter infection. Although we are unaware of any studies demonstrating this with valved catheters, it has certainly been shown with needleless connector devices containing valves.[2-4]

This study has several limitations. The bacterial concentrations used were based on the assumption that 1×10^3 CFU/mL was a representative contamination level for injection ports and that 1×10^6 CFU/mL was an unrealistically high level of contamination, unless the device was visibly soiled. Whether these truly represent clinically relevant levels is uncertain. It is also unclear what role, if any, the use of a pulsatile flush technique played in our results. The Infusion Nursing Standards of Practice make no recommendation regarding the proper technique for flushing catheters,[5] and advocates for both continuous[6] and pulsatile[7,8] techniques have each suggested that their method leads to less blood and fibrin accumulation. What is clear is that there is a great deal of variability in practice,[8] and no method has been shown to be clearly superior.

In this study, there were significant differences in the number of bacteria recovered from the Z5 and IAG catheters. Although it is unknown whether these differences reflect the potential for these devices to become colonized or infected, more study is warranted. New medical devices should be rigorously evaluated before broad use.

TABLE 1. Comparison of Z5 and Insyte Autogard (IAG) Peripheral Vascular Catheters, According to Concentration of Bacteria Used to Inoculate the Devices

Inoculum, CFU/mL		Mean no. of bacteria recovered		
Target	Actual[a]	Z5	IAG	P[b]
1×10^6	523,000	572,500	0	<.001
1×10^5	23,300	376,300	0	.001
1×10^4	1,600	189,470	0	.001
1×10^3	147	0	0	

[a] The inoculum was injected 3 times.

[b] Difference in no. of bacteria recovered, by rank sum test.

ACKNOWLEDGMENTS

Financial support. Disposable materials and devices, including both the Z5 and IAG catheters, were supplied by Becton Dickinson.

Potential conflicts of interest. R.S. reports that he received a grant from Becton Dickinson 5 years ago to do vascular catheter research. P.C. reports that he received an honorarium from Becton Dickinson to present the findings of this research at the 5th Decennial International Conference on Healthcare-Associated Infections in Atlanta, Georgia, in March 2010.

Paul Chittick, MD; Robert J. Sherertz, MD

From the Section on Infectious Diseases (P.C., R.J.S.), Department of Internal Medicine (R.J.S.), Wake Forest University Baptist Medical Center, Winston-Salem, North Carolina.

Address reprint requests to Robert J. Sherertz, MD, Section on Infectious Diseases, Department of Internal Medicine, Wake Forest University School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157 (sherertz@wfubmc.edu).

Presented in part: 5th Decennial International Conference on Healthcare-Associated Infections; Atlanta, Georgia; March 2010 (Abstract 447).

Infect Control Hosp Epidemiol 2010; 31(12):1311-1313

 0899-823X/2010/3112-0022$15.00. DOI: 10.1086/657586

REFERENCES

1. Maki DG, Kluger DM, Crnich CJ. The risk of bloodstream infection in adults with different intravascular devices: a systematic review of 200 published devices. *Mayo Clin Proc* 2006;81:1159–1171.
2. Field K, McFarlane C, Cheng AC, et al. Incidence of catheter-related bloodstream infection among patients with a needleless, mechanical valve–based intravenous connector in an Australian hematology-oncology unit. *Infect Control Hosp Epidemiol* 2007;28:610–613.
3. Salgado CD, Chinnes L, Paczesny TH, et al. Increased rate of catheter-related bloodstream infection associated with the use of a needleless mechanical valve device at a long-term acute care hospital. *Infect Control Hosp Epidemiol* 2007;28:684–688.
4. Rupp ME, Sholtz LA, Jourdan DR, et al. Outbreak of bloodstream infection temporally associated with the use of an intravascular needleless valve. *Clin Infect Dis* 2007;44:1408–1414.
5. Infusion Nurses Society. Infusion nursing standards of practice. *J Infus Nurs* 2006;29:S1–92.
6. Macklin D. Catheter management. *Semin Oncol Nurs* 2010;26:113–120.

7. Hadaway LC. Flushing to reduce central catheter occlusion. *Nursing* 2000;30:74.
8. Fernandez RS, Griffiths RD, Murie P. Peripheral venous catheters: a review of current practices. *J Infus Nurs* 2003;26:388–392.

The 2009 H1N1 Influenza A Pandemic and Hand Hygiene Practices in a Hospital in the South of Brazil

To the Editor—Brazil was severely affected by the 2009 H1N1 influenza A pandemic. The pandemic was most felt in the southern states (8.6 cases per 100,000 inhabitants), a temperate zone region bordering Argentina, Uruguay, and Paraguay.[1]

Hospital de Clínicas de Porto Alegre is a 790-bed, university-affiliated tertiary care hospital located in the southernmost state of Brazil. By late July, the hospital had organized its strategy to respond to the pandemic: suspected patients were seen in a distinct unit, a unique ward and intensive care unit (ICU) were used for inpatient care, and staff training about virus transmission and the benefits of hand hygiene in preventing dissemination was reinforced.[2,3]

From June through September (winter season) 2009, a total of 548 inpatients were evaluated for 2009 H1N1 influenza A infection. Among 154 patients tested for the presence of the H1N1 virus with real-time polymerase chain reaction assay, 75 (48.7%) had positive results.

Adherence to hand hygiene has been monitored by means of direct observation in our ICU since 2006. The ICU staff are aware that observation occurs but cannot detect it or predict when it will occur.

From July 2006 through March 2010, the hand-washing technique of physicians, nurses, and technicians was observed daily for 20–30-minute intervals during 5 morning, 5 afternoon, and 3 night shifts, during all 5 weekdays. Weekends were excluded from the observation schedule. In addition, the consumption of alcohol-based hand rub was measured in milliliters per 100 patient-days.

The 1-sample Student *t* test was used to compare the mean rates of adherence to hand-washing. One-way analysis of variance with the 2-sided Tukey test for multiple comparisons was performed to compare mean differences in adherence between groups of professionals. Time-series segmented regression analysis was used to determine significant changes in level (immediate) and trend (slope) of adherence to hand-washing, before (July 2006 through May 2009) and during and after (June 2009 through March 2010) the 2009 H1N1 influenza A season in Brazil.[4]

From July 2006 through March 2010, 21,438 opportunities for hand hygiene were observed. The overall mean adherence rate was 57.1% (range, 46.2%–69.7%). The mean rate of adherence to hand hygiene was 76.6% (range, 59.5–96.6%) for nurses, compared with 54.1% (range, 43.7%–69.6%) for technicians ($P < .001$) and 44.2% (range, 23.0%–70.6%) for physicians ($P < .001$).

Segmented regression analysis revealed no difference in the observed rate of adherence before the 2009 H1N1 influenza A pandemic, compared with during and after the pandemic (slope change from 0.07 to 0.24; $P = .44$). The use of alcohol-based hand rub from wall dispensers showed no significant difference in immediate consumption in the ICU (level change from 0.83 to 0.28; $P = .17$) but a significant decrease thereafter (slope change from 0.33 to −0.38; $P = .05$). The use of hand rub from wall dispensers throughout the entire hospital showed a transient significant increase in consumption (level change from 0.59 to 0.64; $P < .001$) and a slope decrease thereafter (trend change from 0.59 to −0.36; $P = .02$) (Figure 1).

The mean rate of adherence to hand hygiene before patient contact was 44.5% (range, 23.0%–66.7%) and after patient contact was 74.9% (range, 61.8%–87.5%) ($P < .001$). The segmented regression model revealed no change in the rate of adherence before and after patient contact in relation to the 2009 H1N1 influenza A pandemic.

Despite the increase in consumption of alcohol-based hand rub during the peak period of the pandemic, this behavior was not sustained through the subsequent months. The numerous media reports related to 2009 H1N1 influenza A had an effect in terms of dissemination of hand-washing practices. As reported by the Brazilian Ministry of Health, 89% of people surveyed were informed about the pandemic by television.[5] However, the media most influenced changes in social behavior, and importantly, these changes, as manifested in the hand hygiene practices of healthcare workers, were transient, as we have shown. A change in social behavior does not necessarily lead to a long-term change in hand hygiene practices in hospitals.

Inherent community and home hand-washing practices are a predictor of in-hospital hand-washing behavior,[6-8] which means that, in hospitals, hand hygiene will be performed as one learns at home: one cleans one's hands after they become visibly soiled—in other words, an action to protect oneself. This was the message people received from television: "protect yourself," not "protect your patient." This is why we would not expect a significant change in healthcare worker behavior in hospitals. Direct observation at our hospital revealed no change in hand-washing practices in relation to the World Health Organization (WHO) 5 moments. The mean rate of adherence before patient contact (ie, to protect the patient) was significantly lower than the rate of adherence after patient contact (ie, to protect the healthcare worker), and this scenario did not change after the beginning of the pandemic.

Our data reflect the limitations related to both methods of ascertaining adherence to hand hygiene. The observation