nization rates of 1.5% and 5.8%, respectively. HCWs' adherence with contact precautions was evaluated by use of a questionnaire (Table 1). Because no statistically significant differences were found among the different groups of HCWs (by use of the χ^2 test), it can be supposed that the high rate of MRSA colonization in the nurses' aides group (16%) is probably due to both misuse of gloves and poor compliance with correct procedures for hand hygiene, which can result in the transmission of MRSA.[4,5] The World Health Organization (WHO) multimodal programme "Clean Care is Safer Care," which was started in 2005, has been effective at reducing the spread of MRSA and has a central role to play in improving hygiene practices in hospitals.[6]

Since 2006, the Infection Control Committee at Fondazione Santa Lucia has implemented a hand hygiene improvement programme by introducing the technique of hand rubbing with an alcohol-based solution at the point of care and by monitoring hand hygiene compliance using repeated observational studies on care activities. As recommended by the WHO programme, we also developed training courses and guidelines on hand hygiene based on scientific evidence, and there are reminders in the workplace (eg, "patient partnership activity") that provide a climate of safety in the hospital. However, the above-mentioned educational activities were mainly directed at doctors, nurses, therapists, and other medical staff members, not at nurses' aides.

Our results suggest that, in the curricula of nurses' aides, more emphasis needs to be placed on hand hygiene training and on improving adherence to hand hygiene practice. In fact, in Italy, nurses' aides are supposed to receive 1,000 hours of educational training before they can work in a healthcare setting; however, only a few of those hours are devoted to understanding the WHO guidelines for hand hygiene and implementation surveillance tools. Furthermore, the lack of inclusion of nurses' aides in the Continuing Medical Education program may also prevent them from taking healthcare courses (on these very issues) that are normally organized for other professional HCWs. Because being a nurses' aide at Fondazione Santa Lucia is usually considered a permanent position, their inclusion in the Continuing Medical Education program (ie, in the next set of training and educational courses on hand hygiene) may result in a reduction in the incidence of MRSA colonization among HCWs in our hospital.

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 0899-823X/2010/3110-0025$15.00. DOI: 10.1086/656380

REFERENCES

1. Barbosa AA, Chapin K, Mermel LA. Methicillin-resistant *Staphylococcus aureus* colonization of house officers [published correction appears in *Infect Control Hosp Epidemiol* 2009;30(12):1242]. *Infect Control Hosp Epidemiol* 2009;30(9):912–914.
2. Orsi GB, Marrone R, Ferraro F, Tavella F, Colosi A. Low colonization with MRSA among health-care workers in an Italian hospital. *Ann Ig* 2008;20: 503–508.
3. Monaco M, Bombana E, Trezzi L, et al. Meticillin-resistant *Staphylococcus aureus* colonising residents and staff members in a nursing home in Northern Italy. *J Hosp Infect* 2009;73:182–184.
4. Ludlam HA, Swayne RL, Kearns AM, et al. Evidence from a UK teaching hospital that MRSA is primarily transmitted by the hands of healthcare workers. *J Hosp Infect* 2010;74:296–299.
5. Girou E, Chai SH, Oppein F, et al. Misuse of gloves: the foundation for poor compliance with hand hygiene and potential for microbial transmission? *J Hosp Infect* 2004;57:162–169.
6. Allegranzi B, Pittet D. Role of hand hygiene in healthcare-associated infection prevention. *J Hosp Infect* 2009;73:305–315.

Central Venous Catheter Flushing and an Outbreak of Bacteremia among Pediatric Hematology-Oncology Patients

To the Editor—Wiersma et al[1] reported an outbreak of polymicrobial bloodstream infections in pediatric bone marrow transplant outpatients. The investigation concluded that the preparation of multiple doses of predrawn saline flush solution from a 50-mL single-dose saline vial, which was accessed multiple times, may have led to extrinsic contamination.

The central venous catheter (CVC) is an indispensable tool for the treatment of patients with cancer.[2] One of the major drawbacks of the long-term use of a CVC is the development of CVC-related bacteremia, which increases morbidity, mortality, and healthcare costs.[3] A breach of sterility is a common complication when there is an inappropriate modification of CVC procedures for handling, flushing, and delivering solutions and medications. We experienced an outbreak of CVC-related bacteremia among pediatric hematology-oncology patients caused by a change in the local policy for CVC flushing with heparin solution. In January 1999, there were

17 patients who were diagnosed with CVC-related sepsis during a 10-day period. Table 1 shows the main demographic and clinical characteristics of these 17 patients, all of whom underwent clinical and radiological examination (chest radiograph and/or abdominal ultrasound) to exclude lung or abdominal infectious foci. Blood samples obtained from the CVCs for culture showed a growth of *Pseudomonas aeruginosa* in 14 patients, *P. aeruginosa* and *Serratia marcescens* in 2 patients, and *P. aeruginosa* and *Staphylococcus epidermidis* in 1 patient. All isolated strains of *P. aeruginosa* had the same sensitivity pattern to the following antibiotics: gentamycin, piperacillin, azlocillin, ceftazidim, tobramycin, amikacin, imipenem, and second-generation fluoroquinolones.

Five patients had their CVC removed soon after the diagnosis of CVC-related bacteremia was suspected: 2 patients had their CVC removed because they had febrile seizures, and 3 patients had their CVC removed because they did not need it any longer. For the remaining 12 patients, the salvage of the CVC was attempted by administering intravenous antibiotic treatment. The patients were treated with ceftazidim and amikacin or with tobramycin (or with teicoplanin if needed). Seven patients had their CVC prematurely removed because of persistent CVC-related colonization or infection, whereas 5 patients cleared their infection after a median duration of antibiotic treatment of 7 days (range, 5–12 days). Overall, the CVC was removed in 12 (71%) of 17 patients: 8 (90%) of 9 patients had an infection related to the use of a double-lumen CVC, and 4 (50%) of 8 patients had an infection related to the use of a single-lumen CVC.

A clinical investigation was undertaken to search for potential causes, and it was evident that all patients had had their lines accessed on the same day in the outpatient clinic for routine CVC flushing, collecting of blood samples, or intravenous therapy. The patients started having high, spiking fevers after a median duration of 5 days (range, 1–10 days) after the date of that access.

These spiking fevers and the isolation of a strain of *P. aeruginosa* in the blood samples of all the patients with identical antibiotic sensitivity suggested a common source of infection. We hypothesized that the products used for the preparation of the flush solution (ie, 10-mL normal saline vials of 0.9% NaCl and 5,000-IU/mL sodium heparin vials) were contaminated, but we excluded this hypothesis after microbiological test results on the same batches used that day were found to be negative. We asked the nurses in the outpatient clinic about the CVC handling procedure for flushing, about the use of medication, and about obtaining blood samples, and we found that, several weeks before this outbreak, the modality of preparation of flushing solution had been modified to save time: instead of using a single vial of normal saline and heparin for every CVC flushing (ie, 3 mL of normal saline with 200 IU/mL of heparin), it had been decided to prepare a multidose flushing solution of 500 mL to use for the whole day, stored at room temperature.

TABLE 1. Summary of Demographic and Clinical Characteristics of 17 Pediatric Hematology-Oncology Patients with Central Venous Catheter (CVC)–Related Bacteremia at Azienda Ospedaliera di Padova, Italy (January 1999)

Characteristic	Patients
Median age (range), years	6 (2–17)
Sex	
Male	9
Female	8
Underlying disease	
Acute lymphoblastic leukemia	6
Acute myeloid leukemia	3
Solid tumors	7
Non-Hodgkin lymphoma	1
Type of Broviac-Hickman CVC	
Single lumen	8
Double lumen	9
Organism(s) isolated from blood culture	
Pseudomonas aeruginosa	14
P. aeruginosa and *Serratia marcescens*	2
P. aeruginosa and *Staphylococcus epidermidis*	1
Clinical symptoms at hospital admission	
Pyrexia (temperature, $\geqslant$38.5°C)	17
Polymorphonuclear leukocyte count $<0.5 \times 10^9$ cells/L	4
Vomiting	3
Diarrhea	2
Seizures	2
Septic shock	2
CVC removed	12
Reasons for removal	
Seizures and hyperthermia	2
Persistence of CVC-related colonization	4
Persistence of CVC-related infection	3
CVC no longer needed	3

NOTE. Data are no. of patients, unless otherwise indicated.

It was concluded that a breach of the aseptic rules by nursing personnel caused the contamination of the multidose preparation and the subsequent outbreak of CVC-related bacteremia. Immediately afterward, the policy of preparing every flush solution by single-vial of normal saline and heparin was reintroduced, and a program of surveillance of CVC-related infections was started. No further outbreak of CVC-related bloodstream infection has occurred, and the incidence of CVC-related infections has remained consistently low over a decade.[4,5]

The aseptic technique for CVC insertion and routine care (ie, flushing and medication) and the adequate training and education of healthcare personnel are fundamental to the prevention of CVC-related infections.[6] CVC flushing is routinely performed to prevent malfunctioning or clotting, and current guidelines for the prevention of CVC-related infections recommend the use of single-dose vials for parenteral additives or medications when possible (category II).[6,7] Our experience is further evidence of the importance of asepsis in flushing CVCs and underlines the role of single-dose preparation of CVC solution in preventing outbreaks of CVC-

related bacteremia in the case of an accidental breach of aseptic rules.

In conclusion, we agree with Wiersma et al1 about the high risk of an outbreak of bacteremia when flush solutions are accessed multiple times for the routine care of CVCs, and we think that all CVC procedures require continuous surveillance and supervision by experienced healthcare personnel, to avoid the progressive loss of efficacy of these procedures as a result of the increasing turnover and workload of healthcare personnel.

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REFERENCES

1. Wiersma P, Schillie S, Keyserling H, et al. Catheter-related polymicrobial bloodstream infections among pediatric bone marrow transplant outpatients—Atlanta, Georgia, 2007. *Infect Control Hosp Epidemiol* 2010;31:522–527.
2. Henrickson KJ, Axtell RA, Hoover SM, et al. Prevention of central venous catheter–related infections and thrombotic events in immunocompromised children by the use of vancomycin/ciprofloxacin/heparin flush solution: a randomized, multicenter, double-blind trial. *J Clin Oncol* 2000;18:1269–1278.
3. Fätkenheuer G, Cornely O, Seifert H. Clinical management of catheter-related infections. *Clin Microbiol Infect* 2002;8:545–550.
4. Cesaro S, Corrò R, Pelosin A, et al. A prospective survey on incidence and outcome of Broviac/Hickman catheter-related complications in pediatric patients affected by hematological and oncological diseases. *Ann Hematol* 2004;83:183–188.
5. Cesaro S, Tridello G, Cavaliere M, et al. A prospective, randomized trial of two different modalities of flushing central venous catheter in pediatric hematological patients. *J Clin Oncol* 2009;27:2059–2065.
6. O'Grady NP, Alexander M, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter-related infections. *Pediatrics* 2002;110(5):e51.
7. Mermel LA, Farr BM, Sherertz RJ, et al. Guidelines for the management of intravascular catheter–related infection. *Clin Infect Dis* 2001;32:1249–1272.