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Rethinking Sterilization Practices: Evidence for Event-Related Outdating •

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## Concise Communications

### Low Frequency of Fires From Alcohol-Based Hand Rub Dispensers in Healthcare Facilities

John M. Boyce, MD; Michele L. Pearson, MD

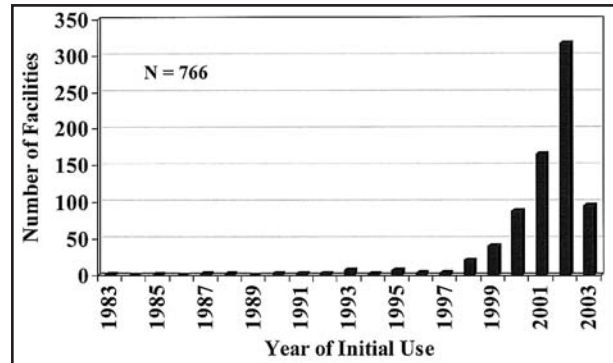
#### ABSTRACT

We administered a web-based questionnaire to SHEA, APIC, and EIN members to assess the frequency of fires associated with alcohol-based hand rub (ABHR) dispensers in healthcare settings. None of the 798 responding facilities using ABHRs reported a dispenser-related fire; 766 facilities had accrued an estimated 1,430 hospital-years of ABHR use (*Infect Control Hosp Epidemiol* 2003;24:618-619).

Alcohol-based hand rubs have been used routinely by healthcare workers (HCWs) in some parts of Europe for decades.<sup>1-3</sup> Compared with soap and water hand washing, these products require less time to use, can be more accessible than sinks, cause less skin irritation and dryness, are more effective in reducing the bacterial count on hands, and when made widely available within an institution, have been shown to improve hand hygiene practices among HCWs.<sup>4</sup> In view of these advantages, the Healthcare Infection Control Practices Advisory Committee of the Centers for Disease Control and Prevention recently recommended the routine use of alcohol-based hand rubs by HCWs, as long as their hands are not visibly soiled with blood or other proteinaceous material.<sup>5</sup> To make these products readily accessible to HCWs, the new Guideline for Hand Hygiene in Healthcare Settings<sup>5</sup> recommends that alcohol-based hand rub dispensers be placed adjacent to patient beds, in hallways immediately outside patient rooms, and in other convenient locations. However, the implementation of alcohol-based hand rubs, particularly the placement of the dispensers in hallways, has been impeded in healthcare facilities in several states because of the concerns of local fire marshals that they may pose a fire hazard.

#### METHODS

To obtain data on the frequency of fires related to alcohol-based hand rub dispensers, we administered a web-based questionnaire to members of the Society for Healthcare Epidemiology of America (SHEA), the Association of Professionals in Infection Control and Epidemiology (APIC), and the Emerging Infections Network (EIN) of the Infectious Diseases Society of America in March 2003. We obtained information regarding the routine use of alcohol-based hand rubs in facilities, the date (month and year) that the use began, the location of the dispensers within the facilities, and



**FIGURE 1.** Trends in the use of alcohol-based hand rubs in healthcare facilities in the United States, from January 1983 through March 2003. Source: Society for Healthcare Epidemiology of America, Association of Professionals in Infection Control and Epidemiology, and Emerging Infections Network online survey, March 2003.

whether any fires had been attributed to the dispensers. We also asked whether they had been instructed by local fire marshals to remove or relocate the dispensers from hallways, change the size of the dispensers, or change the storage conditions of large stocks of alcohol-based hand rubs. Finally, we calculated the months of use of alcohol-based hand rubs for each facility and the cumulative months of use for all respondents. For the 122 (16%) facilities that reported only the year that alcohol-based hand rubs were implemented, we arbitrarily assumed that use began in July of the respective year.

#### RESULTS

A total of 840 nonduplicate responses representing 50 states and the District of Columbia were returned within 7 days of posting the questionnaire; 798 respondents (95%) reported that alcohol-based hand rubs were being used in their facilities. Although a few facilities had been using alcohol-based hand rubs since the 1980s, 87% started using them routinely after January 2000 (Fig. 1). Dispensers were located in patient rooms in 80% of facilities, in treatment rooms in 89% of facilities, and in hallways in 61% of facilities. The initial date of use of alcohol-based hand rubs was available for 766 (96%) of the facilities; these facilities had accrued an estimated combined total of 1,430 hospital-years of use of an alcohol-based hand rub. None of the 798 respondents in facilities using such products reported that a fire attributed to (or involving) an alcohol-based hand rub dispenser had occurred in his or her facility.

Ten percent (78 of 771) and 8% (60 of 777) of the facilities, respectively, reported that local fire marshals had instructed them to change the storage conditions of

large stocks of alcohol-based hand rubs or to change the location or size of the alcohol-based hand rub dispensers. Overall, 11.4% (42 of 369) of the facilities reported that a local fire marshal had told them to remove the alcohol-based hand rub dispensers from hallways. The proportion of respondents who had been told to remove hand rub dispensers from hallways varied dramatically by geographic region, ranging from none (0 of 161) of the facilities in 26 states to more than 50% (13 of 14) of the facilities in 5 states (Fig. 2). In many states, one or more facilities had been told to remove dispensers from hallways, whereas others in the same state had not been instructed to do so.

The interstate and intrastate variability in the actions taken on this issue by local fire marshals may relate in part to the existence of at least two different fire codes regarding flammable products in healthcare facilities.

## DISCUSSION

Our study has several limitations. Due to the manner in which the study was conducted, the responding facilities do not represent a statistically valid sample of all healthcare facilities in the United States. The fact that 95% of respondents reported using alcohol-based hand rubs suggests that personnel working in facilities using these products were more likely to complete the questionnaire than were those working in institutions where such products had not yet been adopted. Also, members of SHEA, APIC, and EIN who did not have Internet access or whose e-mail addresses were not registered with these organizations could not participate in the survey. Nonetheless, the data provided by the survey, when combined with decades of experience with alcohol-based hand rubs in Europe,<sup>2,3</sup> suggest that the incidence of fires associated with the use of these products in healthcare settings is extremely low.

Because increased use of alcohol-based hand rubs has been shown to improve adherence with hand hygiene among HCWs and to reduce healthcare-related infections,<sup>6,7</sup> we believe that the potential benefits of having these products available in easily accessible areas of healthcare facilities (eg, hallways) far outweigh the apparent low (and undocumented) potential fire hazard that may occur with their use.

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**FIGURE 2.** Proportion of responding facilities instructed to remove alcohol-based hand rub dispensers from hallways, by state (N = 369).

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## A Nosocomial Outbreak of *Legionella pneumophila* Caused by Contaminated Transesophageal Echocardiography Probes

Pierre-Yves Levy, MD; Nadine Teyssie, PhD;  
Jérôme Etienne, MD, PhD; Didier Raoult, MD, PhD

### ABSTRACT

A case-control study of three cases of *Legionella pneumophila* pneumonia identified transesophageal echocardiography (TEE) as a risk factor. Patient isolates and environmental strains from water used for rinsing TEE probes were identical by pulsed-field gel electrophoresis. This is the first report of endoscopy as a potential source of legionellosis (*Infect Control Hosp Epidemiol* 2003;24:619-622).

Hospital-acquired *Legionella pneumophila* pneumonia has a high fatality rate (higher than 30%) and an increasing incidence.<sup>1</sup> The most frequently reported route of transmission has been through contaminated aerosol; however, transmission through aspiration of contaminated water has also been reported.<sup>2</sup> Hot water distribution systems have been shown to be the primary reservoirs for *Legionella* species. Transmission of microorganisms via endoscopes has been suspected but never reported for *L. pneumophila*, to the best of our knowledge. We describe 3 patients diagnosed as having *L. pneumophila* pneumonia apparently acquired from contaminated transesophageal echocardiography (TEE)

probes in the same 300-bed clinic, from June 26 through 29, 2000.

## PATIENTS

### Case 1

A 48-year-old man with mitral insufficiency was hospitalized for cardiac insufficiency. TEE was performed 1 week after admission and the patient developed pneumonia 7 days later. Bronchoalveolar lavage (BAL) was then performed and was positive for serogroup 1 *L. pneumophila*. Results of the *Legionella* urinary antigen test were also positive.

### Case 2

A 76-year-old man was hospitalized for atrioventricular dysfunction. TEE was performed and the patient developed pneumonia 6 days later. BAL culture was negative. Results of the *Legionella* urinary antigen test were positive twice, and the indirect fluorescent antibody test for *L. pneumophila* showed a seroconversion from negative to 1:256.

### Case 3

A 75-year-old man was hospitalized for atrial dysfunction. TEE was performed on the day after admission and the patient developed pneumonia 2 weeks later. BAL culture recovered serogroup 1 *L. pneumophila*. Results of the urinary antigen test were negative twice, 2 and 10 days after the onset of pneumonia. Indirect fluorescent antibody testing showed a conversion from a negative baseline titer to 1:256 in the convalescent titer.

## METHODS

We collected 1 L of cold and warm water from each of 21 different taps within a week after the third diagnosed case. A solution containing 0.5 mL of 0.1 N sodium thiosulfate was added to neutralize the residual-free chlorine.<sup>3</sup> Human and environmental specimens were cultured on buffered charcoal-yeast extract medium (bioMérieux, Marcy l'Etoile, France) and glycine-vancomycin-polymyxin B-cycloheximide selective agar (Oxoid, Dardilly, France), with and without heat treatment, following the usual procedures for the isolation of *Legionella* species.<sup>3</sup> Identification of *Legionella* isolates was performed using a *Legionella* latex test kit (Oxoid) and confirmed by polymerase chain reaction amplifying the macrophage infectivity potentiator gene.<sup>4</sup>

The urinary antigen test (Société Binax, Portland, ME) detecting specific lipopolysaccharide antigen of *L. pneumophila* serogroup 1 was used according to the manufacturer's instructions.<sup>5</sup> Antibodies in serum samples were estimated by using the indirect immunofluorescent antibody test as previously described.<sup>6</sup>

Chromosomal pulsed-field gel electrophoresis analysis was performed on the isolates as previously described.<sup>7</sup> Briefly, legionellae were treated with proteinase K (50 µg/mL) in TE buffer (10 mM of Tris-HCl and 1 mM of EDTA; pH 8) for 24 hours at 55°C, and DNA was digested with 20 IU of *Sfi*I restriction enzyme

(Boehringer Mannheim, Meylan, France) for 16 hours at 50°C. Fragments of DNA were separated in a 0.8% agarose gel prepared and run in 0.5% Tris-borate-EDTA buffer (pH 8.3) in a contour-clamped homogeneous electric field apparatus (CHEF DR II PFGE system, Bio-Rad Laboratories, Ivry sur Seine, France) with a constant voltage of 150 V. Runs were performed with constant pulse times (25 seconds) at 10°C for 11 hours and increasing pulse times (35 to 60 seconds) at 10°C for 11 hours. Isolates with patterns that differed by no more than three restriction fragments were considered to have the same pulsetype, whereas organisms differing by more than three restriction fragments were considered sufficiently divergent to warrant a separate pulsetype designation.<sup>8</sup>

The outbreak occurred in a 300-bed private hospital. After two affected patients were identified, an investigation was started and a case-control study was initiated. A case-patient was defined as any patient who had either *L. pneumophila* isolated from BAL or a positive result on the *Legionella* urinary antigen test. Each case was matched to four control-patients without evidence of legionellosis, who were hospitalized at the same time either in the same unit for any reason or for the same reason in a different unit. Risk factors identified were TEE, BAL or bronchoscopic aspiration, mechanical ventilation, the use of nebulizers, the use of oxygen humidifiers, shower use, the use of the ice machine, drinking nonbottled water, and the location of patient rooms. Data on possible risk factors were abstracted from clinical records and Fisher's exact test was used to compare frequencies of exposure for cases and controls.

## RESULTS

Three patients were diagnosed as having *L. pneumophila*, two by positive culture from BAL and one by positive result on urinary antigen test (Table). The two cases for which serology was performed showed seroconversion. An outbreak was identified because three cases were diagnosed in 3 days in the same clinic. Patients were hospitalized for 6 to 12 days after TEE, prior to the onset of infection, and therefore likely suffered nosocomial infection. The case-control study demonstrated that TEE was the only significant risk factor for the three case-patients (3 of 3 vs 0 of 12;  $P = .002$ ). Following this finding, investigators from the infection control team reviewed the current practices and noted that the TEE probes had been disinfected inside the examination room equipped with two taps. One tap, which was used for the rinsing procedure, was equipped with a 0.2-µ filter. The second tap, theoretically used for hand washing only, did not have a filter. A new nurse had reversed the use of the taps during the last step of the rinse procedure before drying. Drinking water was not given to patients to assist in swallowing the probe. Using the appropriate water supply, sending the TEE probes to the central sterilization unit for disinfection, and improving the control of chlorination were associated with termination of the outbreak.

TABLE  
NOSOCOMIAL OUTBREAK OF *LEGIONELLA PNEUMOPHILA* CAUSED BY TRANSESOPHAGEAL ECHOCARDIOGRAPHY

Case No.	Gender/ Age (y)	Date of Admission	Underlying Disease	Date of TEE	First		Diagnosis		
					Date of Pneumonia	Date of Diagnosis	Culture	Urinary Antigen	Sero-Conversion
1	M/48	June 12	Aortic stenosis	June 20	June 27	June 28	+	+	NP
2	M/76	June 10	Ventricular dysfunction	June 23	June 29	June 30	-	+	+
3	M/75	June 15	Atrial dysfunction	June 16	June 28	June 5	+	-	+

TEE = transesophageal echocardiography; NP = not performed.

Nine different isolates of *L. pneumophila* were isolated from the water samples, including those from the tap wrongly used during the outbreak for rinsing the TEE probes. Clinical isolates from the two culture-positive patients, two other cases diagnosed previously within the year, and the nine environmental strains were compared by pulsed-field gel electrophoresis. Pulsetypes of the two patients from this outbreak and one environmental isolate from the TEE room (environmental strain 8) were nearly identical. Strains from previous cases and other strains found in the environment water supplies exhibited other pulsetypes (Figure).

## DISCUSSION

In this study, by investigating three cases of nosocomial legionnaires' disease in a clinic, we were able to identify a single significant risk factor (ie, TEE with a probe rinsed with contaminated water) and a single clone isolated from two patients and from the water used to rinse the endoscope. Therefore, there is strong circumstantial evidence that patients were infected by a contaminated probe during TEE. This is the first description of the involvement of such a procedure in the nosocomial transmission of *L. pneumophila*. Nasogastric tubes have been implicated in legionnaires' disease, presumably by microaspiration of contaminated water.<sup>9</sup> A pseudoepidemic has been reported in which contaminated bronchoscopes resulted in false-positive cultures from clinical samples taken at bronchoscopy from healthy patients.<sup>10</sup> This report does not represent a pseudoepidemic because clinical infection was present and *Legionella* was confirmed to be the etiologic agent by *Legionella* antibody seroconversion or a positive result on the urinary antigen test in each patient. It suggests that endoscopic instruments can become contaminated following adequate disinfection procedures if non-sterile water is used for the final rinse.

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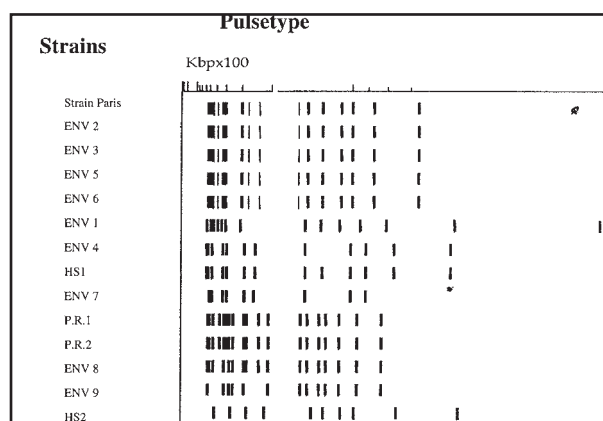


FIGURE. Pulsed-field gel electrophoresis analysis of strains of *Legionella pneumophila* 1. Strain Paris = reference strain; ENV = environmental strains (ENV 8 was collected in the water used to rinse the transesophageal echocardiography probe); HS = human strains obtained the year before in this institution (*L. pneumophila* 1: HS1; *L. pneumophila* 3: HS2); P.R. = present work strains.

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## Rethinking Sterilization Practices: Evidence for Event-Related Outdating

Joan Webster, RN, BA; Wendy Lloyd, RN; Ping Ho, RN; Christine Burridge, RN; Narelle George, BSc, MSc

### ABSTRACT

A prospective study was conducted during a 2-year period to evaluate the effectiveness of event-related outdating. Hospital-prepared sterilized items (n = 152) were shelved in wards and every 3 months, several articles were retrieved and microbiologically tested. During the 2-year period, all of the items tested were sterile (*Infect Control Hosp Epidemiol* 2003;24:622-624).

Most Australian hospitals continue to observe time-related expiry dating for hospital-prepared sterilized items. Shelf life is usually set at 1 month after processing, and after this time, stock is returned to the sterilizing department for repackaging and reesterilization. Evidence to support the 1-month shelf life is lacking, but it is generally attributed to recommendations published in 1983 by the Center for Disease Control.<sup>1</sup> More recent guidelines support event-related outdating, which purports that sterile goods remain sterile indefinitely unless packaging integrity is compromised. This concept has been tested in practice conditions.<sup>2,3</sup> As there are clear cost benefits associated with adopting an event-related outdating approach,<sup>4</sup> it is difficult to understand why hospitals continue to observe the older standard.

Adherence with time-related expiry dating may be due to the argument that there is no way of knowing whether an "event" has occurred or to difficulties in interpreting the newer guidelines, which include attention to the type and configuration of packaging materials used, the number of times a package is handled before use, storage on open or closed shelving, the condition of the storage area (eg, cleanliness, temperature, and humidity), the use of dust covers, and the method of sealing dust covers.<sup>5</sup>

Investigations to date have not tested the safety of shelf life in uncontrolled conditions nor has event-related outdating beyond a 12-month period been examined. Moreover, newer, high-quality wrapping materials have been introduced in recent years that were unavailable when data were collected for previous studies. The purpose of this study was to test event-related outdating dur-

**Shelf Life Project**

**4 weeks to go**

**How will it work?**

- ⇒ From 31 May, all sterile stock will carry a new label which will look something like this → Sterile unless dropped or damaged  
Date processed 31/5/99
- ⇒ There will be no need to return stock to the CSSD unless an 'EVENT' has occurred to the package.
- ⇒ Old stock should be used first i.e. stock should be rotated as before
- ⇒ There will be a number of SHAM articles amongst your stock. They will be labelled

**FOR RESEARCH  
DO NOT USE**

- ⇒ These articles should be rotated in the same way as normal sterile stock.
- ⇒ Every 3 months, two articles from each ward will be opened and tested for sterility. This process will continue for 2 years.

This is an important project with far-reaching implications for the management of sterile stock in Australian hospitals.

FIGURE. Prestudy information. CSSD = Central Sterilising Department.

ing a 2-year period in a variety of environmental conditions.

### METHODS

In June 1999, following intensive staff education about event-related outdating and information about the study (Figure), 152 packs containing 304 test items were prepared by the staff of the Central Sterilising Department of the Royal Women's Hospital, Brisbane. Packs contained a copper rod wrapped in a green hand towel, simulating a surgical instrument. A cotton ball, simulating linen, was placed on top of the green towel. Packs were wrapped in Kinguard (Kimberley-Clarke, Milson Point, New South Wales, Australia), Dextrex S (Drager Medical Australia, Notting Hill, Victoria, Australia), or green crepe (Charles R. Gabb and Co., Sumner Park, Brisbane, Australia) and sealed with sterilizing indicator tape. Copper rods were also placed in appropriately sized, laminated pouches (Steripeel, Bard Australia, North Ryde, New South Wales, Australia). All items were sterilized on the same day. A biological indicator (EZ TEST, Austmel, Nerang, Queensland, Australia) was processed with the loads to ensure effective sterilization.

Packs were distributed to five areas of the hospital

(two operating theaters, the neonatal intensive care nursery, and two postnatal wards) where they were stored on either closed or open shelving. No dust covers were used. Only 2 of the areas were air conditioned. Every 3 months during a 2-year period, a predetermined number of items were removed from the shelves in each area and sent to the pathology department. Toward the end of the study period, 3 hospital-packed items found in the trunk of a community vehicle (dated 1992) were also included.

Packs were opened in a biohazard hood and the contents were transferred under sterile conditions into individual bottles containing tryptone soy broth and incubated at 35°C for 7 days and a further 7 days at 28°C. Bottles were examined for turbidity or evidence of microbial growth after incubation. Results were reported as “no growth” or “growth” with organism identification. The testing of the three items from the community vehicle differed only in that the entire surface of the item was swabbed with a sterile cotton-tipped swab that was then immersed in the tryptone soy broth.

## RESULTS

During the study period, the hospital was relocated to a new building and the remaining test packs were reshelved. In the move, 21 packs were lost to follow-up. Of the original sample, 131 (86.2%) of the packs containing 262 test items were available for testing. Nine items were returned to the Central Sterilising Department because an “event” had occurred: 2 had had their wrapping torn, 6 had been dropped, and 1 had blood on the outer wrapping. These packs were included in the testing process as were the items from the community vehicle. After 14 days of incubation, all 262 test items were sterile.

## DISCUSSION

The study was designed to test event-related outdating in suboptimal settings. Many of the storage areas in the old hospital were not air conditioned and did not comply with current best practice standards. For example, in one of the operating rooms there was no geographic or physical division between “clean” and “dirty” areas. Hospital-prepared sterile stock was stored on open shelving, near the sluice area. Conditions were cramped and stock was handled frequently. Similarly, in the neonatal nursery, sterile stock was stored on open shelving in a large storage room, along with other nonsterile nursery items. The area was located between two wards and was accessible from both. As a consequence, the area was used as a corridor and carried a large volume of traffic. Despite these conditions, all test articles remained sterile.

Perhaps the most surprising finding was associated with the hospital-prepared scissors and forceps, wrapped in laminated pouches and retrieved from a box in the trunk of a community vehicle. The articles had been there for 9 years prior to testing and would have been exposed to a great deal of handling. Because Brisbane has a subtropical climate, temperatures and humidity levels would

have been extreme at certain times of the year. It was also interesting that none of the articles that had suffered an “event” in the hospital was contaminated.

These results challenge the existing belief that “the probability of a contaminating event occurring increases with time and handling.”<sup>6</sup> Results support the concept that products, when correctly wrapped and sterilized, will remain sterile unless the wrapping is damaged. Although 2 years was the longest period that test items were stored in this study, there is no reason to suggest that this period should be the limit of shelf life. If stock is rotated, items should not require reprocessing unless they have been contaminated. However, common sense suggests that goods that remain on shelves unused for this period may not need to be there.

During the study, the Central Sterilising Department at the Royal Women’s Hospital was amalgamated with the Royal Brisbane Hospital’s sterilizing service into a combined Sterile Processing Centre located in the new hospital. An audit conducted at the conclusion of the study showed that approximately 18,000 date-expired items were returned to the Sterile Processing Centre for reprocessing annually. A formula for estimating the cost of time-related expiry dating has been proposed that includes reprocessing labor costs, restocking supply costs, and reprocessing supply costs.<sup>7</sup> However, even using a conservative estimate of \$5.00 per item will yield a recurrent cost savings of approximately \$90,000 per year when event-related outdating is implemented across the two hospitals. In calculating costs, waste disposal may be an additional consideration.

It was unfortunate that not all packs were recoverable. We went to extraordinary lengths to find them, but were unable to do so. This was one limitation of the study. Another limitation was that we included only small packs, whereas larger items may have been more susceptible to damage. However, quality monitoring following the implementation of event-related outdating elsewhere found that the integrity of all sterile items was maintained.<sup>4</sup> We believe that event-related outdating is safe and cost-effective and should replace time-related expiry dating.

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## Use of Pulsed-Field Gel Electrophoresis in Infection Control Issues Concerning *Burkholderia cepacia*

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### ABSTRACT

There was concern that nosocomial person-to-person transmission of *Burkholderia cepacia* had occurred when two patients with cystic fibrosis shared a bathroom. Pulsed-field gel electrophoresis demonstrated that the two isolates were unrelated. Subsequent testing of 34 stored isolates of *B. cepacia* demonstrated that no particular clone predominated in our hospital (*Infect Control Hosp Epidemiol* 2003;24:624-626).

*Burkholderia cepacia* is an aerobic, glucose nonfermenting, motile gram-negative bacillus found in soil and water and is a member of the family of Pseudomonadaceae to which patients with cystic fibrosis (CF) are particularly susceptible.

In the 1980s, adverse effects of *B. cepacia* in patients with CF were first noted in the United States.<sup>1</sup> Later, a mortality rate of 80% was reported for patients with CF who received bilateral lung transplants when colonized with *B. cepacia* genomovar III.<sup>2</sup> Epidemiologic evidence has emerged that social contact between patients with CF is a risk factor for the spread of *B. cepacia*, although this is probably from direct contact with sputum and saliva via fomites rather than aerosolization of the organism by coughing.<sup>3</sup> This has led some centers to introduce strategies to reduce the spread of *B. cepacia* among patients with CF (eg, segregation of carriers of *B. cepacia* from those without it), although this remains controversial.<sup>4</sup>

The aim of this study was to examine the epidemiology of strains of *B. cepacia* in a hospital where segregation of patients with CF is practiced. PFGE demonstrated that person-to-person transmission of *B. cepacia* had not occurred at a time when there was suspicion that it had.

### METHODS

#### Setting

The Alfred Hospital is a 350-bed, tertiary-care referral university hospital in metropolitan Melbourne. It has a

large respiratory unit that provides a statewide referral service for adults with CF (approximately 250 patients receiving ongoing follow-up) and a national lung transplant service that performs 40 lung transplants each year.

### Patients

Patient A with CF was admitted to the respiratory unit with an infective exacerbation of CF-related lung disease. The stay overlapped with that of patient B (also admitted for intravenous antibiotic therapy for CF-related lung disease) by 3 days. Patient B was known to be colonized with *B. cepacia* and, in accordance with published infection control guidelines,<sup>5</sup> was subject to certain practices to help reduce the transmission of *B. cepacia*. These practices included segregation to avoid close contact with other patients, emphasis on personal hygiene (frequent hand washing and careful sputum disposal), and not sharing equipment (eg, eating and drinking utensils and respiratory equipment). Contact precautions are not routinely employed in our hospital and healthcare workers do not wear special apparel. Patients with *B. cepacia* are allocated a single room and, on this occasion, both patients A and B had their own rooms; however, they shared a bathroom. On the final day of hospitalization, patient A had a sputum sample taken that subsequently grew *B. cepacia*. There was concern that nosocomial person-to-person transmission had occurred.

### Identification

*B. cepacia* was identified by the culturing of sputum directly onto oxidation-fermentation base-polymyxin B-bacitracin-lactose medium and species was determined using VITEK nonfermenter cards (bioMérieux, Marcy l'Etoile, France) and confirmed by the API 20NE bacterial identification system (bioMérieux). Eighteen of the isolates had been sent to a reference laboratory and all were subsequently confirmed to be *B. cepacia* by DNA-based testing.

### Chromosomal DNA Restriction Patterns by PFGE

Isolates were grown on horse blood agar at 37°C overnight and a turbid cell suspension (0.45 to 0.5 OD<sub>595</sub> nm) in 10 mM of Tris-chloride and 1 M of NaCl was made. The cell suspensions were mixed with equal volumes of 2.4% wt/vol low-melting point agarose and blocks were prepared. These were treated with lysis buffer (6 mM of Tris-chloride, pH 7.6; 1 M of NaCl; 100 mM of EDTA, pH 7.6; 0.2% deoxycholate; and 0.5% N-laurylsarcosine) with freshly added lysozyme (Sigma, St. Louis, MO) at 10 mg/mL and incubated at 37°C for at least 2 hours. Protein digestion was achieved by transferring the blocks into an ESP solution (0.5 M of EDTA, pH 9.0; 1% sarkosyl; and 1 mg/mL of proteinase K) and incubating overnight at 50°C. The DNA was digested with restriction enzyme *SpeI* at 37°C overnight. Quarter blocks were loaded into wells of 1% agarose gel in a 0.5 × TBE solution (44.5 mM of Tris-base, pH 7.6; 44.5 mM of boric acid; and 1 mM of EDTA) and PFGE was performed using the Gene



Navigator apparatus (Pharmacia-Biotech, Uppsala, Sweden). The conditions for electrophoresis were 170 V for 25 hours using pulse times of 5 seconds for 10.5 hours, 25 seconds for 10.5 hours, and 45 seconds for 4 hours in a stepped program. Molecular markers ( $\lambda$  DNA concatemers, Pharmacia-Biotech) were included with each gel run. Gels were stained with ethidium bromide for 30 minutes and photographed under ultraviolet transillumination. DNA profiles were interpreted according to guidelines published by Tenover et al.<sup>6</sup>

## RESULTS

The PFGE band pattern is shown in the figure. There are more than seven different bands between the isolates of the two patients; therefore, they are not of the same clone. Phenotypically, both isolates had the same appearance; however, they did show differing antibiotic susceptibility profiles.

Thirty-four isolates collected between 1995 and 2000 were examined by PFGE. There was no recorded outbreak of *B. cepacia* in the hospital during this period. Twenty-one patients with CF provided 26 samples of sputum yielding *B. cepacia*: 3 individuals provided 2 isolates each and 1 individual provided 3 isolates. These repeat cultures were analyzed in this study as these samples were collected at least 6 months apart for each individual. Eight isolates were from blood or sputum cultures of patients without CF.

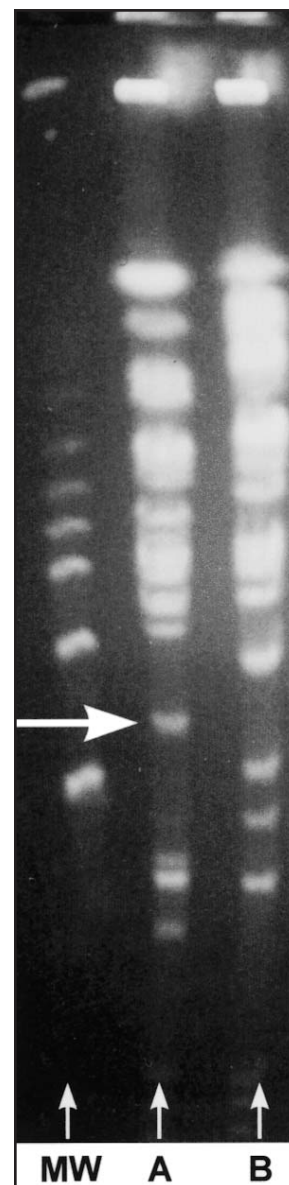
By PFGE, every individual had a genetically different isolate (data not shown). The patients who provided more than one isolate, however, were found to have genetically identical strains at each point in time.

## DISCUSSION

This study has demonstrated by molecular biology that nosocomial spread of *B. cepacia* did not occur between patient A and patient B. In addition, it showed that our hospital has not had one predominant strain of *B. cepacia* during a 5-year period. This situation had been reported in Australia once before, in one of the two hospitals described by Paul et al.,<sup>3</sup> as well as in the United States.<sup>7</sup> However, both in Australia and elsewhere, certain strains of *B. cepacia* can predominate in an institution, perhaps as a result of nosocomial spread.<sup>3,8</sup> Instances of person-to-person spread of *B. cepacia* have been well documented both in and out of the hospital.<sup>9</sup>

PFGE of chromosomal DNA fragments has been described as the "gold standard" of strain typing of *B. cepacia* isolates<sup>10</sup> for surveillance studies. PFGE for clonal identification has clear benefits over phenotypic methods. Different clones may have identical colony morphology and biochemical reactions and often have similar results on antimicrobial susceptibility testing, making these relatively insensitive tests for determining clonal variation unlike PFGE. However, PFGE is not a routine test offered by every diagnostic laboratory. It requires moderately expensive equipment and some specialized technical skills. It also takes 3 to 4 days to obtain a result.

The infection control practices of our hospital are



**FIGURE.** Transilluminated pulsed-field gel electrophoresis showing different band patterns (large arrow) for the *Burkholderia cepacia* isolates of our two patients. MW = molecular weight marker; A = patient A; B = patient B.

based on published guidelines<sup>5</sup> and we propose to follow the advice of Govan,<sup>4</sup> continuing the policy of patient segregation and careful surveillance for *B. cepacia* in which analysis using PFGE is vital. If nosocomial spread was confirmed using PFGE, this evidence would be used to dictate changes in the infection control policy. PFGE is a relatively simple procedure that can help reassure individuals needing hospitalization that when two patients have the same organism, person-to-person spread may not have necessarily occurred. This is especially important in a setting where there are potentially significant problems with failing to identify person-to-person transmission (eg, in patients with CF who have decreased respiratory host defenses and increased needs for social interaction and support).

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## Vaccination Without Documentation: Influenza Immunization Among Medical Residents at a Tertiary-Care Medical Center

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### ABSTRACT

Sixty-four percent of medical residents unimmunized by the Occupational Health Service were immunized elsewhere. Those unvaccinated lacked time to comply. An immune staff is critical to prevent transmission to high-risk patients and limit absenteeism. The hospital is implementing a program to deliver medical care to the house staff (*Infect Control Hosp Epidemiol* 2003;24:626-628).

Despite national recommendations that healthcare workers who have contact with patients should be vaccinated for influenza, recent studies suggest that compliance among healthcare workers remains low.<sup>1,2</sup> As medical residents are frequently the first-line providers for hospitalized and debilitated patients, it is crucial that they be immunized for influenza yearly.

Although staff may be immunized in a variety of settings, influenza vaccination is offered through the hospital Occupational Health Service (OHS). Given the perennially low rate of influenza vaccination in our academic medical center, we sought to determine the true rate of immunization and, if it was low, improve compliance among our medical housestaff. A campaign was organized to bring the influenza vaccine to resident conferences, the general medical clinic, and intensive care units. Housestaff were notified of influenza vaccine availability by the chief resident's office, broadcast e-mails, and broadcast text paging. All vaccines were administered by the OHS. Despite these efforts, the rate of immunization remained below 50%. This study was undertaken to determine the accuracy of vaccination status and to define the reasons for noncompliance with influenza vaccination among the medical housestaff.

## METHODS

A list of all medical housestaff vaccinated for influenza by the OHS was cross-checked with the medical housestaff roster provided by the department of medicine. All housestaff not immunized were contacted by pager and interviewed by telephone, using a standardized questionnaire. All responses were documented anonymously. The institutional review board approved the study and questionnaire.

The questionnaire had three principal objectives. The first was to determine whether the house officer had indeed been vaccinated, and if so, where? Second, those not vaccinated were asked whether they were aware of the ongoing influenza immunization campaign. Finally, the housestaff were asked why they chose not to comply. All results were descriptive and were finalized as proportions.

## RESULTS

Of the 127 medical housestaff, 61 (48%) were formally vaccinated by the OHS. Of the 66 medical house officers not vaccinated by the OHS, 53 (80%) were successfully interviewed. Thirty-four (64%) of those interviewed reported having been vaccinated for influenza during the fall and winter of 2001–2002. Twenty (59%) of the 34 vaccinated were immunized by a colleague in the general medical clinic and 14 (41%) were vaccinated elsewhere. Of these 14 house officers, 6 were vaccinated at an off-site clinical rotation; 3 were vaccinated by the OHS; 1 was vaccinated by the military (Army Reserves); 2 were vaccinated at an unspecified hospital location; 1 was vaccinated in the dialysis center; and 1 was vaccinated at home by a physician-spouse (Figure).

Nineteen of the 53 residents interviewed were not vaccinated for influenza in the winter of 2001–2002, although they were aware of the ongoing hospital vaccination campaign. Three (16%) of the 19 were afraid of side effects. One house officer (5%) had a medical contraindication to immunization. One house officer (5%) refused vaccination due to pregnancy. Fourteen (74%) of 19 house

officers were not vaccinated because either they were too busy or vaccination was too inconvenient.

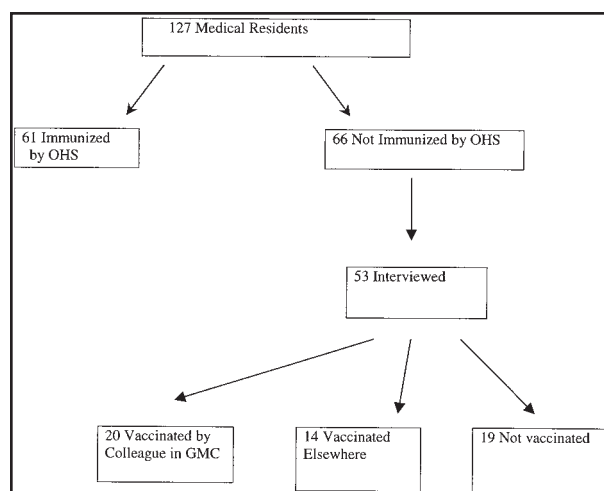
## DISCUSSION

The medical housestaff in this tertiary-care, academic medical center appeared to have a perennially low rate of influenza vaccination. The overall proportion of medical house officers immunized by the OHS was below 50% even after a 3-month period (October through December) of aggressive promotion of immunization through the chief medical resident's office and broadcast e-mails and paging to notify housestaff of vaccination at the general medical clinic, resident conferences, and intensive care units.

Low levels of compliance with vaccination have been well documented in the literature.<sup>3-5</sup> Several studies have defined the reasons for noncompliance in healthcare systems.<sup>3,6</sup> The respondents have included physicians, nurses, and laboratory and clerical personnel. This study, however, focused exclusively on the reasons for the non-compliance of medical house officers with influenza vaccination. In one sizeable survey, common reasons for non-compliance included fear of side effects, reaction to the vaccine, and the belief that the vaccine is not necessary due to the perceived low likelihood of getting influenza.<sup>2</sup> Being too busy was uncommonly cited as a reason for nonacceptance of the influenza vaccine.<sup>2</sup> One academic medical center, however, reported rates of influenza immunization as high as 99% among their medical residents.<sup>7</sup> In this setting, residents were immunized in the medical clinic by medical clinic nursing staff, not in the employee health service.

All of the nonvaccinated respondents were aware of the ongoing campaign for influenza vaccination. Although efforts were made to bring the vaccine to areas of resident activity such as clinics, conferences, and intensive care units, 74% of nonvaccinated respondents cited being too busy and the inconvenience of the vaccination as the main reasons to forego vaccination. Few reported a fear of side effects. None reported a lack of vaccine efficacy as a deterrent to vaccination. The perception of lack of time appears to be the main barrier to vaccination of medical residents in our institution.

A significant proportion (64%) of housestaff not vaccinated by the OHS were indeed immunized for influenza in the winter of 2001–2002. Most were vaccinated by housestaff colleagues in the general medical clinic at an opportune time. Others reported vaccination by colleagues on hospital floors, in the dialysis unit, and at home. According to the medical bylaws, this is unacceptable for several reasons. First, they were using a vaccine designated for patients. Second, and perhaps more important, the hospital specifically forbids housestaff to deliver informal or casual medical care to each other for a variety of reasons, which include the inability to document the technique of administration, handling, and storage of the vaccine and safety issues. Because these immunizations had been neither documented nor report-



**FIGURE.** Medical residents vaccinated for influenza. OHS = Occupational Health Service; GMC = general medical clinic.

ed to the OHS, these residents were not formally registered as having been vaccinated for influenza. Furthermore, this informal method of immunization underscores the apparent importance of convenience and accessibility in overcoming noncompliance with influenza vaccination. Three of the presumed nonvaccinated residents responded that they had indeed been vaccinated by the OHS. It is not known whether there had been an error in documentation.

These alternate vaccination sites spuriously decrease the rate of influenza vaccination among medical housestaff as vaccination is undocumented by the OHS. The total number of housestaff vaccinated for influenza, including those identified by this study, was 95 (75%) of 127 residents compared with 48% recorded by the OHS. It is important for hospital epidemiology and occupational health practitioners to document the influenza immunization status of employees to ensure a safe environment for high-risk patients. Knowledge of the influenza vaccination status of employees is critical in an outbreak to better allocate immune personnel to areas of direct patient care. This will both prevent nosocomial transmission of infection to older, high-risk patients, in whom the efficacy of immunization is approximately 58%,<sup>8</sup> and limit worker absenteeism. This is particularly relevant to medical housestaff who frequently function as the first-line providers of care.

Of medical residents not vaccinated for influenza, most cited the inconvenience of the vaccination and being too busy as the reason for noncompliance, underscoring the importance of convenience and accessibility. To address the issues of inconvenience and compliance with the medical bylaws, the hospital is implementing a more convenient system for delivering comprehensive medical care to the housestaff. Each resident will be assigned to an accessible attending physician through the OHS who will be responsible for his or her health care. By addressing all of the problems associated with the convenience of

medical care for house officers, the expectation is that compliance with the recommendations for influenza immunization within the healthcare system will improve. This is important to ensure the safety of high-risk patients during the influenza season.

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