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Cluster of *Pseudomonas aeruginosa* catheter-related bloodstream infections traced to contaminated multidose heparinized saline solutions in a medical ward

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Abstract

Intravascular catheters are indispensable in modern medical practice; healthcare institutions purchase millions of them each year. The present study describes an outbreak of *Pseudomonas aeruginosa* catheter-related bloodstream infection (CRBSI) in a medical ward of the associated hospitals, a teaching hospital with 1005 beds, in Ancona, Italy, with details of the source of infection and the efficacy of the control measures adopted. The environmental strain of *P. aeruginosa* was isolated from the mixture of heparin and saline solution. Clinical and environmental isolates were identical at PFGE, showing that the outbreak had been caused by a single clone of *P. aeruginosa.* The frequency of *P. aeruginosa* bacteraemia depends on the population of patients studied; our patients did not show risk factors that increased their susceptibility to hospital infections. As these pathogens cannot be eradicated from the hospital environment, constant infection control measures are needed in order to prevent nosocomial infections.
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Keywords: *Pseudomonas aeruginosa*; Nosocomial bloodstream infection; Bacteremia; Infection control

Introduction

Intravascular catheters are indispensable in modern medical practice; healthcare institutions purchase millions of them every year. Peripheral venous catheters are the devices most frequently used for vascular access. Although the incidence of local or bloodstream infections (BSIs) associated with peripheral venous catheters is usually low, serious infectious complications give rise to considerable annual morbidity because of the frequency with which such catheters are used. Patients are at great risk of local and systemic infectious complications, including local site infections, catheter-related bloodstream infection (CRBSI), septic thrombophlebitis, endocarditis, and other metastatic infections. Saline flushes and other intravenous multidose medications have also been reported to transmit viral pathogens such as HIV, HBV, HCV, or bacteria (Krause et al., 2003). The incidence of CRBSI varies considerably according to type of catheter, frequency of catheter manipulation, and patient-related factors (e.g., underlying disease and severity of illness) (CDC, 2002). The distribution of over 21,500 bloodstream isolates

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from the CDC's NNIS in ICU patients from 1992 to 1999 (data comparable with those observed in extensive hospital surveillance) shows that Gram-positive cocci predominate the profile with coagulase-negative staphylococci. *Pseudomonas aeruginosa* was responsible for 3.8% of nosocomial BSI (CDC, 1999).

The present study describes an outbreak of *P. aeruginosa* CRBSI in a medical ward of the Associated Hospitals, a teaching hospital with 1005 beds in Ancona, Italy, with details of the source of infection and the efficacy of the control measures adopted.

Methods

Epidemiological surveillance: In May 2004, the hospital hygiene service received a report on microbiological cultures from the microbiology laboratory, which revealed four blood isolates of *P. aeruginosa* with identical antimicrobial susceptibility. The strains were recovered (May 25–28, 2004) from four patients who had had at least one febrile episode ($>38\,^{\circ}C$) during their hospital stay.

Data were collected, including demographic information, admission diagnosis, date of onset of fever, medications, type of vascular access, and results from clinical cultures. All patients were admitted to the gastroenterology ward with 13 beds.

Epidemiological investigations started on 1 June 2004; patients with a diagnosis of CRBSI were investigated, and bacteremia was defined as occurring in a patient with an intravascular catheter with at least one positive blood culture obtained from a peripheral vein, clinical manifestations of infection (fever, chills, and/or hypotension), and no apparent source for the BSI except the catheter (Rupp, 2004).

In each case, possible risk factors (patients, nursing care, and environment) were examined. Since the four patients had received intravenous therapy before their febrile episodes, three possible common sources of infection were considered: (1) antiseptics used for disinfection of skin and mucosa; (2) infusion therapy; and (3) heparinization.

Bacterial isolates: P. aeruginosa isolated from blood cultures was identified by the microbiology laboratory from biochemical profiles obtained with the Vitek 2 system, GNI card (bioMérieux).

An environmental search for the pathogen was carried out by the hygiene laboratory. Antiseptics used for treating skin and mucosa, saline solutions of various lots for infusion therapy, sealed heparin solution vials, mixtures of heparin and saline solution prepared extempore and used to flush peripheral catheters to prevent clotting, and sealed saline solutions of the same lot as those used to dilute heparin, were all examined for bacterial culture.

Media containing neutralization substances were used to culture antiseptic solutions: nutrient broth for alcohol, aldehyde, chlorine compounds and phenols, and nutrient broth + Tween 80% for biguanides, iodine compounds, phenols and detergents, and quaternary compounds.

Identification was carried out by API 20NE (bioMérieux).

A standardized antimicrobial susceptibility testing was performed by means of the Vitek 2 system.

PFGE typing was performed after digestion of bacterial DNA with the *SpeI* restriction enzyme.

Results

Epidemiological surveillance: From 25 to 28 May 2004, four patients received infusion therapy in the same medical ward. All patients with febrile episodes had received infusion therapy, with heparinization of the infusion line. No febrile episodes were observed among other patients not submitted to this procedure in the period from 16 May to 5 June. The underlying diseases of the four patients were inflammatory bowel disease, connective tissue disorders, and alcoholic hepatitis; none of them had previously been given antibiotics. In these patients, *P. aeruginosa* CRBSI occurred after peripheral catheters had been flushed with a multidose mixture of heparin and saline solution by nursing personnel. Heparinazed saline for use in heparin locks was prepared by adding 1 ml from a heparin solution vial to 100 ml saline solution. These diluted solutions were prepared at a nurse station and kept at room temperature. This supply of heparinized saline was commonly used for flushing for 3–5 days until it was finished, and variable amounts from 2 to 5 ml were used each time. The mixture in the bottle was available for bacterial culture.

As a result of microbiological tests, nursing staff were reproved and asked to follow very closely recommended hygiene procedures aimed at preventing catheter-related infections, and only to use single-dose diluted heparin solutions.

Bacterial isolates: Bacterial cultures carried out on the antiseptics in use, the saline solutions for infusion therapy, sealed heparin solution vials, and sealed saline solutions of the same lot as used to dilute heparin and involved in the outbreak, were all negative. The environmental strain of *P. aeruginosa* was isolated from the mixture of heparin and saline solution. The five isolates (four from patients' blood and one from the mixture of heparin and saline solution) had identical resistograms and were identical at PFGE, showing that the outbreak was caused by a single clone of *P. aeruginosa* (Fig. 1).

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