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Undetected *Bacillus* pseudo-outbreak after renovation work in a teaching hospital

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Air-ventilation;
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Laundry

Summary A 602-bed capacity hospital underwent complete renovation from 1999 to 2004. In April 2005, the Infection Control Team was informed of the occurrence of three consecutive cases of *Bacillus cereus* bacteremia in a ward for patients with hematologic malignancies. A retrospective analysis of patients with *Bacillus* isolates was initiated. We found more *Bacillus cereus* isolates from blood samples in 2004 compare to the preceding years. Swab samples were collected in the particular ward from the surface of a working desk, filter unit of the air-conditioners, entrance of air inlet ducts, exit of the air outlet ducts and three-way valves of the particular ward under the consideration of iatrogenic contamination. Towels and gowns used in the ward were examined. Dens dust was noted in the filter of the air-conditioner and inlets/outlets of the air-ventilation system of the ward. *Bacillus cereus* was isolated from the dust, and from cleaned towels and gowns. PFGE fingerprinting differed among four patients' sample. We considered the present case as an undetected *Bacillus cereus* pseudo-outbreak that lasted for about one year after the renovation work of the hospital. We also considered that filters of the HVAC-system and towels and gowns were probable sources of the outbreak. © 2006 The British Infection Society. Published by Elsevier Ltd. All rights reserved.

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Introduction

Bacillus cereus, a gram-positive, rod-shaped, spore-forming aerobe is widely distributed in nature, and is a well-recognized cause of toxin-mediated food poisoning.¹ It also

causes rare systemic infections usually in immunocompromised patients.² These rare non-gastrointestinal infections are associated with wound injuries and burns, hemodialysis, immunocompromise, parenteral drug abuse, blood transfusion, and spinal anesthesia.³

There have been few reported outbreaks of non-gastrointestinal *Bacillus cereus* infections, including two in neonatal intensive care units (NICU)^{4,5} and one in an adult intensive care unit (ICU).⁶ An unusual outbreak of *Bacillus* species in which calcium gluconate vials were implicated has also been reported.⁷ A pseudo-outbreak is a situation in which an organism is recovered from culture at a rate that is greater than expected and that cannot be clinically correlated with the supposed infection indicated by the results of culture.⁸ This situation may result from systemic extrinsic contamination during specimen collection or processing or intrinsic contamination at the time the culture medium is manufactured or prepared.⁹ Dissemination of *Bacillus* species in hospitals has been reported,¹⁰ however, most of the episodes were pseudo-outbreaks. Recognizing and tracking the source of such pseudo-outbreaks can be a difficult task.^{8,11}

Evidence obtained from epidemiological studies and laboratory measurements supports the hypothesis that a contaminated heating, ventilation and air-conditioning (HVAC)-system may be a source of pollutants. Humidifiers, dirty air duct, and dirty filters could all be the perfect sites for amplification and dissemination of indoor fungi. Some investigations have suggested that microbial contamination might be present in construction materials, ventilation systems, or results from human activities.^{12,13} However, contamination of the HVAC-system has not been recognized as a cause of *Bacillus* outbreak.

In the present report, we describe an increase of *Bacillus cereus* isolates from blood samples in a teaching hospital after general renovation work of the building. The HVAC-system and the laundry process were considered as the probable sources by tracking the incidence.

Background

The teaching hospital

An 11-story teaching hospital with 602-bed capacity was built in 1976. Each floor was divided into two segments, an east ward and a west ward, by an elevator hall. Each ward has around 48 beds. Maintenance of the air-ventilation system and cleaning of the hospital was in accordance with the national guidelines established by the Japanese Government.

In this hospital, blood culture was not included among routine examinations. Usually it was performed when patients presented a sudden bout of high fever or showed signs of severe infection especially these with an indwelling continuous intravenous line for infusions. Blood samples were usually taken by veno-puncture or arterial puncture. An environmental survey was not carried out on a regular basis in the hospital.

General renovation of the hospital

General renovation of the teaching hospital began in 1999 and finished in 2004. A new building was added to the

hospital on the east side to increase the floor surface by 150%. The renovation was accomplished in three phases. First, the new eastern building was built between 1999 and August 2001. Renovation of the old eastern part, which became the central part, started after the extension work. During this period of time the new eastern part and the old western part were used. Then, the old western part followed by the first, second and third floor of the central part were renovated using the eastern part and above the fourth floor of the central part. After the renovation work, the building was divided into western ward and eastern ward again. All renovation work of the wards finished by March 2004. During the renovation, each working part was tightly separated from those under construction by temporary walls.

The old hospital had a heat air-ventilation system but did not have an air-conditioning system. The renovated hospital is equipped with an HVAC-system, which includes an air-ventilation system and a heat and cool air-conditioning system. There are air inlet ducts, air outlet ducts of the air-ventilation system and units of circulating air-conditioner in the ceiling of each room and corridor. Outside air enters through an air intake with air-filters located on the roof of the hospital and is distributed through the air-ventilation system. Each air-conditioner is equipped with a simple one-layer air filter made of a plastic-fiber net. The laundry is located in the first basement floor of the eastern part.

Bacillus cereus bacteremia cases

In April 2005, the Infection Control Team of the hospital was informed of the detection of three consecutive *Bacillus cereus* positive blood cultures from febrile patients with severe blood stream infection in a ward for patients with hematologic malignancies which located on the fourth floor of the western part. White blood cells counts in these cases were low due to anti-malignancy chemotherapy and they had an indwelling continuous venous line. These three cases were experienced during an interval of three weeks. Although sporadic cases of blood culture positive for *Bacillus cereus* had been found all around the hospital, positive cultures from three consecutive patients had hardly been experienced. We first considered these three cases as an iatrogenic infection, therefore an investigation by the Infection Control Team was launched.

Methods

Retrospective analysis of isolates

The hospital has a reporting system for the detection of major pathogens such as multi-drug resistant *Staphylococcus aureus* (MRSA) and multi-drug resistant *Pseudomonas aeruginosa* (MDRP). *Bacillus* species were not under surveillance although it had been recovered from a blood sample. However, all data of bacteria isolated from most samples were recorded in the main database. A retrospective analysis of cases of *Bacillus* species isolated from blood samples was initiated using the database.

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