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Major Article

Suspicious outbreak of ventilator-associated pneumonia caused by *Burkholderia cepacia* in a surgical intensive care unit

LiPing Guo MD [a], Gang Li MD [b], Jian Wang MSNurs [b], Xia Zhao MSNurs [a], Shupeng Wang MD [b], Li Zhai MSNurs [b], Hongbin Jia MLT [c], Bin Cao MD [a,d,*]

[a] *Nosocomial Infection Control Office, China-Japan Friendship Hospital, Beijing, China*
[b] *Center for Respiratory Diseases, Department of Pulmonary and Critical Care Medicine, China-Japan Friendship Hospital, Capital Medical University; National Clinical Research Center of Respiratory Diseases, Beijing, China*
[c] *Surgical Intensive Care Unit, China-Japan Friendship Hospital, Beijing, China*
[d] *Department of Clinical Laboratory, China-Japan Friendship Hospital, Beijing, China*

Key Words:
Health care–associated infection
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Background: We reviewed *Burkholderia cepacia* infections in a hospital from 2013-2016 to report a suspicious outbreak that occurred in a surgical intensive care unit in 2015, and to outline the infection control measures adopted thereafter.

Methods: Review of the health care–associated infection data regarding *B cepacia* via the surveillance system, hospital information system, electronic medical records, and laboratory information system together with the outbreak investigation was managed by the health care–associated infection control team.

Results: During June 1-14, 2015, 4 cases of ventilator-associated pneumonia (VAP) were identified; *B cepacia* was isolated from endotracheal aspirate samples. On June 16, 120 environmental samples were collected and analyzed for microbiologic differentiation. Thirteen strains of *B cepacia* were prominently found in the expiratory blocks of ventilators, revealing the biocontamination source. After chemical disinfection without damaging ventilator components, repeat microbiologic testing of random ventilator samples yielded negative results until July 30, 2015. Retrospective data showed that isolation rates of *B cepacia* strains had increased since 2014. Although the resistance phenotype of these strains varied slightly, they exhibited similar patterns of antibiotic susceptibility.

Conclusions: Routine cleaning and disinfection of ventilators, in addition to an intervention bundle, should form part of an integrated VAP prevention and management approach.

BACKGROUND

Pneumonia has a high rate of morbidity and mortality and is responsible for significant health care costs. Patients in intensive care units (ICUs) receiving mechanical ventilation have a high risk of developing ventilator-associated pneumonia (VAP), a serious infectious complication occurring in critically ill patients.[1,2] In the United States in 2012, the incidence of VAP for various types of hospital units ranged from 0.0-4.4 per 1,000 ventilator days.[3] In China, multicenter prospective monitoring of the incidence of VAP in 46 hospitals, conducted from October 2013-September 2014, showed an incidence of 4.5-32.8 per 1,000 ventilator days. This estimate is higher than that reported in the United States and even higher than the 90th quantile fractile.[4] After the implementation of evidence-based preventive VAP practice bundles and enforcement of national VAP-targeted surveillance, the VAP incidence in some areas in China has begun to decline over the last 2-3 years. For example, in a 1,600-bed comprehensive tertiary hospital in Beijing in 2015 in the medical ICU, the total mechanical ventilation duration was 3,472 days and the incidence of VAP was 1.44 per 1,000 ventilator days. In the surgical ICU, where total ventilation duration was 5,192 days, VAP incidence was 3.47 per 1,000 ventilator days. Nevertheless, antimicrobial-resistant pathogens are an emerging issue. Ventilators serve as reservoirs for pathogens and have the potential to facilitate patient-to-patient transmission of bacteria. In 2015, there was a suspicious outbreak of VAP in the surgical ICU of this hospital; *Burkholderia cepacia* was confirmed as the causative pathogen.

* Address correspondence to Bin Cao, MD, Center for Respiratory Diseases, Department of Pulmonary and Critical Care Medicine, China-Japan Friendship Hospital, Capital Medical University; National Clinical Research Center of Respiratory Diseases, Yinghua East St No 2, Chaoyang District, Beijing, China.
E-mail address: caobin1999@gmail.com or caobin_ben@vip.163.com (B. Cao).

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B cepacia is an opportunistic pathogen known formerly as *Pseudomonas cepacia*. It is a gram-negative, oxidase-positive, nonfermenting, motile aerobic bacillus that is capable of surviving in the presence of certain disinfectants and has intrinsic resistance to multiple antibiotics. In the late 1970s, identification of *B cepacia* cultured from the sputum of patients with cystic fibrosis did not support the previously held idea that *B cepacia* was only a plant pathogen in the natural environment. Over the last few years, small health care–associated infection outbreaks involving *B cepacia* have occurred, usually caused by contamination of medical devices or products. These outbreaks have affected patients without cystic fibrosis or chronic granulomatous disease, but rather with hospital-associated and immunocompromised conditions.[5] The density of *B cepacia* in sputum can exceed 10^8 colony forming units (CFUs)/mL, implying that direct contact with respiratory secretions may be the greatest risk for *B cepacia* respiratory infection.[6] In this study, we aimed to review *B cepacia* infections in a hospital from 2013 to the first half year of 2016 to report a suspicious outbreak of ventilator-associated *B cepacia* infection that occurred in a surgical ICU in 2015, and to outline the infection control measures adopted thereafter.

MATERIALS AND METHODS

Description of the clinical setting

The study was conducted in a large, general 1,600-bed hospital. Since 2002, all hospitalized patients were enrolled into the Beijing health care–associated infection control surveillance network. This active surveillance system collects case data on health care–associated infections among hospitalized patients (≥48 hours after admission) who fulfill the case definition. Data of cases, including demographic characteristics, diagnostic and treatment information, laboratory tests and interpretation, and health care–associated infection control measures, are collected. Case data are derived automatically and semi-automatically from the hospital information system, electronic medical records, and laboratory information system. In addition to case data, data on periodical surveillances of disinfection of air, water, hands, and equipment of health workers, environmental surfaces, invasive devices, disinfectants, and apparatuses also are collected. The infection control team of each clinical department in the hospital analyze and provide feedback data to the surveillance system. Members from the clinics and wards who are the grassroots, the health care–associated infection control administrative office, which is the middleclass leader for administration, the clinical microbiology laboratory, and the pharmacist also are included in the infection control team. The committee of infections of the hospital is the top leader of the infection control team for long-term strategy and significant resolution.

The hospital has 4 ICUs: medical, cardiac, emergency, and surgical. All provide advanced life monitors and support care for critically ill patients aged ≥18 years. The surgical ICU serves as a surgical and medical polyvalent ICU; there are 4 single rooms and another 26-bed room. Patients are not separated according to the type of underlying disease, and bed occupancy is always >85%. In the surgical ICU, the human resource, space, equipment, and technical support allocations conform to the Chinese guideline for construction and management in ICUs.[7] The physician-to-bed ratio is 0.8:1, and the nurse-to-bed ratio is approximately 3:1. Air cleaning technology is adopted in the ICU working area, of which biologic surveillance index refers to a class III clean operating theater. There are 28 ventilators in the surgical ICU. The ICU has no respiratory therapist. Two ICU technicians maintain (clean, sterilize, adjust, service, and repair) medical devices to ensure that ventilators are in good working order.

One attending physician and 1 nurse are appointed by the dean of the surgical ICU as assistants to play a main role of infection control in the department and are trained in infection control programs organized by the hospital twice a year. One or 2 full-time staff of the health care–associated infection control administrative office in the hospital is present for supervision and instruction of practices, such as preventing, reporting, and controlling health care–associated infections. In the ICU, normal objective health care–associated infection monitoring apart from the hospital general surveillance is performed to assess high-risk factors for health care–associated infection outbreaks. This involves standard collection and analysis of target data regarding central line–associated bloodstream infections, catheter-associated urinary tract infections, surgical site infections, multidrug-resistant organism infections, and VAP.[8]

Definition of VAP and the intervention bundle

The diagnostic criteria for VAP were defined according to the literature, combining clinical, microbiologic, and radiographic outcomes as follows[9-12]:

- Mechanical ventilation for ≥48 hours;
- Chest radiograph image exhibiting new or progressive pulmonary infiltrates;
- Temperature >38°C or leukocytosis $>12.0 \times 10^9$/L, or leukopenia $<4.0 \times 10^9$/L;
- One of the following: (1) before initiating empirical antimicrobial therapy, purulence endotracheal aspirate; (2) suggestive auscultation findings; (3) oxygenation changes with low oxyhemoglobin saturation; or (4) increased pulmonary oxygen consumption; and
- A pathogen was considered causative if isolated from 2 consecutive specimens.

The indications for lower respiratory tract or blood culture in ventilated patients and chosen therapy were at the discretion of the attending physician. Endotracheal aspirate and blood phlebotomy specimen for pathogen isolation were obtained aseptically by nurses. The endotracheal aspirate was collected through the endotracheal tube, inserting a sterile catheter connected to an aspiration device into the airway, and the aspirated secretion (1 mL) was placed in a sterile container directly. Sputum smear showing organisms or neutrophils >25 per high-power field fulfilled the criteria, and 10^5 CFUs/mL on final culture of the aspiration indicated VAP, possibly in combination with positive blood cultures. For the blood phlebotomy, 1 blood culture from 2 different sites was drawn when body temperature exceeded 38°C or a pathogen was isolated from other body fluids or discharge samples.

Within 24 hours of a case of VAP being diagnosed, the attending physician completed a standardized reporting form, which was uploaded to the surveillance system and included data on demographic characteristics, disease severity, exposure to mechanical ventilation, risk factors for infection, date of infection, organism(s) isolated on microbiologic testing, and results of antimicrobial susceptibility testing. Once the full-time staff of the health care–associated infection control administrative office in the hospital note the information of the surveillance system, an oral report via telephone is also required to control the infection and prevent the outbreak.

To reduce VAP, the following infection prevention and control measures were universally implemented as an entire bundle of evidence-based practices[9-11]: