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Original Article

Management of Suspected Nosocomial Infection: an Audit of 19 Hospitalized Patients with Septicemia Caused by *Bacillus* Species

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SUMMARY: From April to August of 2000, *Bacillus* spp. were detected in the blood culture of 29 patients in a hospital in Japan. Of these patients, 19 had clinical signs of septicemia; positive culture in the remaining 10 patients was attributed to contamination with skin flora at the site of puncture. Of the 18 strains evaluated, 15 were *Bacillus cereus*, 2 were *Bacillus subtilis*, and one was *Bacillus licheniformis*. The only hospital death observed was that of a patient who had no clinical signs of septicemia at the time of blood sampling. That death is now considered attributable to the underlying neoplasm. The hospital committee for prevention of nosocomial infection concluded after a critical review of the patient records that the cause of septicemia in most cases had been contaminated intravenous lines. To control the situation, the committee recommended the use of a new skin disinfectant, and medical personnel were advised to avoid infusion pauses with interruption of intravenous lines and to replace the caps for the stopcocks with new ones each time the caps were removed. These measures were rigorously observed in addition to the conventional measures for preventing catheter sepsis, and the incidence of septicemia due to the *Bacillus* spp. declined dramatically thereafter.

INTRODUCTION

Recently, official guidelines for infection control in intravenous therapy, established by an advisory committee, organized to propose adequate guidelines (1) for prevention of various types of nosocomial infections, were published. According to the guidelines, the following instructions, as measures of maximal priority for infection control, were graded "priority A":

1. Parenteral nutrition should be avoided when enteral nutrition is applicable.
2. Intravenous solution and additives for total parenteral nutrition should be mixed with adherence to strict aseptic methods.
3. Additives to be mixed with intravenous solution should be kept to a minimum, and the introduction of stopcocks and other junctions to the line should be avoided where possible.
4. Intravenous solution should be administered as soon as possible after preparation and should not be stored for later use.
5. Insertion of multi-lumen catheters should be avoided when possible.
6. Subclavian approach should be considered as the first-choice for catheter insertion when the procedure is performed outside of the operation theater or intensive care unit (ICU).
7. Maximal antiseptic barrier precaution should be observed when inserting the intravenous catheter.

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The recommendations regarding three-way stopcocks were of lower priority. The manual recommends refraining from the usage of such items outside of specialized facilities such as ICU (rated as "priority C"), and disinfecting the junction with ethanol when it is connected or disconnected ("priority E"). No precautions were mentioned regarding the reuse of caps to cover an interrupted intravenous line after disconnecting the line at the three-way stopcocks.

A recent outbreak of septicemia caused by *Bacillus* spp. occurred at Komaki Municipal Hospital. The microorganism was detected in the blood samples from 29 hospitalized patients who had undergone blood culture between April and August 2000 because of fever (over 38°C) or as follow-up for septicemia. The incidence of detection was considered to be unusually high given that the rate of detection of this type of bacteria in blood cultures is reportedly in the range of a few percent (1-3). Through a survey of the patient characteristics and the hospital environment, the hospital committee for prevention of nosocomial infection estimated that the route of infection lay within the intravenous infusion system, and managed to control the situation through various preventive procedures that consisted primarily of refraining from reuse of caps for the three-way stopcocks. Summary of the infection control procedure is reported as an example of successful evaluation and management of nosocomial infection.

MATERIALS AND METHODS

In Komaki Municipal Hospital, *Bacillus* spp. were detected from blood culture samples of one patient in 1996, of no patients in 1997, 2 in 1998, and 9 in 1999. In 2000, *Bacillus* spp. were first detected in one patient in April, in 2 patients

in May, 3 in June, 6 in July, and 17 in August; in 29 patients total. The incidence of blood culture examination between April and August 2000 was 1,204, and the number of samples positive for microorganisms was 154 (12.8%). This means that the detection rate of *Bacillus* spp. from the blood culture samples was 2.4%, which amounted to 18.8% of all the samples that turned out to be positive. These patients had undergone blood culture either for the evaluation of fever exceeding 38°C or as follow up for already acquired septicemia. The physician in charge of each patient was requested to fill out the inquiry form shown in Table 1. The forms, completed for all 29 patients found positive for *Bacillus* spp., were analyzed retrospectively. Of these patients, 10 were considered to have had contamination with skin flora at the time of sample collection. The febrile status of 5 cases was alleviated without therapy; fever in 3 other cases was apparently due to other diseases; and samples of the remaining 2 cases had been taken for follow-up study of septicemia after fever had subsided. Details of the remaining 19 patients who were clinically diagnosed as having septicemia due to *Bacillus* spp. were analyzed.

Komaki Municipal Hospital includes three building wings, and floors 3 through 7 of the East wing, floors 3 through 7 of the South wing, and floor 3 of the North wing are used as hospital wards. Some wards underwent bacteriological evaluation consisting of cultures of various environmental and instrumental surfaces. The manner in which the intravenous lines and catheters were cared for by the hospital personnel was then investigated for each ward, and analyses were made to investigate for a correlation with the rate of *Bacillus* related septicemia in each ward. Various working surfaces within the ward were wiped with sterile materials, and then they were inoculated on stamp media specific for *Bacillus* spp.

Table 1. Inquiry form on patients with *Bacillus* bacteremia

1. Name of the patient _____ 2. Clinical record number _____
3. Date of birth _____ 4. Age _____
5. Underlying disease _____
6. Clinical signs of septicemia yes no
7. Duration of fever (over 38°C) _____ days
8. Comments on the immunological status of the patient
9. Performance status 0 1 2 3 4
10. Clinical data (leukocyte count, CRP, etc.)
11. Ward _____ Room number _____
12. Name of the patient who stayed in the same room during the period of fever elevation and his (her) clinical status _____ _____
13. Site of skin puncture for taking a blood culture sample _____
Method of sterilization of the site of puncture _____
14. Other microorganisms detected by the blood culture _____
15. Type of intravenous line (choose one)
Central venous route Peripheral route
Infusion pause with heparin lock yes no
16. Content of the infusion fluid
17. Facility where the infusion fluid was prepared during the 7 days prior to fever elevation
(choose one) hospital ward centralized pharmacy
18. Drug injection from the side lines yes no
19. List of the drugs administered through side lines
20. Details of therapeutic considerations against fever elevation
21. Details of management of the septicemia after the detection of *Bacillus* spp.
22. Outcume of the patient
23. Cause of death in case the patient died

Date:

Signature of the physician in charge _____

Bacteriological tests were employed to classify the *Bacillus* spp. into various strains in order to determine whether the microorganisms had been transmitted on a patient-to-patient basis. For this purpose, identification of H antigen was performed with original sera 1-8, enterotoxins was detected with CRET-RPLA kits (Denka-Seiken, Tokyo), and the content of cereulide was measured with a vacuolation factor on HEp-2 cells (4-9). A drug sensitivity test was performed with these strains so that effective antibacterial therapies could be given.

Results of all investigations were analyzed by the hospital committee for prevention of nosocomial infection, and discussions were held to establish various preventive measures in order to control the situation. Several important decisions made by the committee are described chronologically, below.

RESULTS

Identification of the *Bacillus* strains

By mid-July, there had been 11 reported cases of bacteremia caused by *Bacillus* spp. that in the past had rarely been detected in the blood culture. Since an outbreak of some form of nosocomial infection was suspected, the inquiry form mentioned above was designed and completed for all 11 patients, and investigation into the origin of the infection was commenced. For the *Bacillus* spp. detected thereafter, further laboratory investigations were performed to identify the subspecies. Therefore, exact strains of the remaining 18 cases were identified, and among these 15 were *B. cereus*, 2 were *B. subtilis*, and one was *B. licheniformis*. Through reviewing the inquiry forms, it was clear that 11 of the 15 patients with *B. cereus* and one of the 2 patients with *B. subtilis* had clinical evidence of septicemia, whereas the remaining 4 patients with *B. cereus*, one patient with *B. subtilis* and one with *B. lichenformis* were considered to be cases of contamination. Of the remaining 11 *Bacillus* spp. in which the exact strain was not identified, 7 were considered causative agents for the septicemia. In summary, 19 of 29 patients in the current study were clinically diagnosed with septicemia caused by the *Bacillus* spp. and the remaining 10 patients were considered cases of contaminations.

Patient demographics

The characteristics of all 19 patients excerpted from the inquiry forms are summarized in Table 2. Food-poisoning symptoms commonly associated with *B. cereus* infection, and diarrhea in particular, were not observed among these patients. The clinical course of patients with septicemia was generally indolent. The only patient who died after detection of the microorganism was one with malignant tumor of the parotid gland. He was in a state of recovery from sepsis due to an other known pathogen when a *Bacillus* strain was detected by chance in a blood culture taken to confirm that the septicemia had been resolved. This patient had no fever and was no longer in the state of sepsis in terms of clinical manifestations at the time of detection of the *Bacillus* strain or thereafter, and the death was considered to be resultant from the underlying malignancy. No other case of death was reported among the 29 patients. Of the 19 cases of sepsis, 15 were promptly resolved following a few days of fever elevation, whereas the *Bacillus* spp. turned out to be resistant to the antibiotic therapy in the remaining 4 patients. On 16th August, urgent notification of the outbreak of *Bacillus* spp. shown in Table 3 was distributed to all hospital wards, including the details of recommended antibacterial therapies for patients with suspected septicemia, and reference to the results of drug sensitivity

Table 2. The characteristics of all 19 patients excerpted from the inquiry forms

Case number	Age	Sex	Underlying Disease	Duration of fever	Compromised patient or not	Venous line	Heparin lock	Drugs injection from side line	Outcome	Species
1	64	M	Lung cancer	1 day	YES	Peripheral	NO	NO	Alive	Unknown
2	67	M	Pacemaker	1 day	YES	Peripheral	NO	NO	Alive	Unknown
3	41	M	Spino-cerebellar degeneration	2 days	YES	Central	NO	NO	Alive	Unknown
4	50	F	Breast cancer	1 day	NO	Peripheral	NO	YES	Alive	Unknown
5	68	M	Leukemia	3 days	YES	Central	NO	YES	Alive	Unknown
6	66	M	Hepatoma	6 days	NO	Central	NO	NO	Alive	Unknown
7	71	M	Dissecting aneurysm	4 days	YES	Central	NO	YES	Alive	Unknown
8	54	F	Ileus	6 days	NO	Central	YES	YES	Alive	Unknown
9	49	F	Breast cancer	1 day	NO	Peripheral	NO	YES	Alive	Cereus
10	60	M	Herpes encephalitis	3 days	YES	None	NO	NO	Alive	Cereus
11	70	F	Liver cirrhosis	2 days	NO	Peripheral	YES	YES	Alive	Cereus
12	64	F	(Origin unkown) cancer	6 days	YES	Peripheral	NO	YES	Alive	Cereus
13	31	M	Pyothrax	2 days	NO	Central	NO	YES	Alive	Cereus
14	72	M	Lung cancer	1 day	NO	Peripheral	YES	NO	Alive	Cereus
15	78	F	Colon cancer	8 days	NO	Central	NO	YES	Alive	Cereus
16	67	F	Cholecystitis	1 day	YES	Central	NO	YES	Alive	Cereus
17	52	M	Cholecystitis	1 day	YES	Peripheral	NO	YES	Alive	Cereus
18	68	M	Multiple myeloma	1 day	NO	Peripheral	YES	NO	Alive	Subtilis
19	67	M	Lung cancer	1 day	YES	Central	NO	YES	Alive	Cereus

tests (Table 4). No serious episode of *Bacillus*-related septicemia was observed thereafter.

Table 5 shows the interpretation of various data derived from critical review of the inquiry forms and environmental survey of the hospital wards by the hospital committee for prevention of nosocomial infection.

On 29th August, the hospital committee analyzed the data in the inquiry forms and discussed measures to reduce the incidence of *Bacillus*-related infections. The discussion regarding the origin of the *Bacillus* spp. can be summarized as follows.

The *Bacillus* spp. may have been transmitted from the hands of medical personnel or could have originated from other infection sites within the patients themselves. *Bacillus* infection in humans generally takes the form of food-poisoning. Given that no patient presented with diarrhea or other food-poisoning related symptoms, secondary infection from other infectious sites was considered unlikely. Hemolysis test, carbohydrate degradation test, detection of H antigens and enterotoxins, and cereulide test were performed to identify the subspecies of *Bacillus* spp., and it was evident that at least 6 genetically different subspecies existed among the 12 specimens examined. The results of these laboratory tests are summarized in Table 6. There was only one occasion in which *Bacillus* spp. were detected in 2 patients who inhabited the same room during the same period. From these data, it seemed unlikely that the microorganisms spread from patient to patient. This analysis of data led to the conclusion that the origin of the infection was likely the hands of hospital personnel.

Rapid onset and clinical course of patients who were clinically diagnosed with sepsis strongly suggested that the infection was essentially catheter sepsis, despite the fact that one patient had received no intravenous administration within a week of the blood culture. If this was true, the microorganisms were considered to have gained access to the bloodstream through the following two routes: 1) contamination of intravenous infusion fluid or additives, and/or 2) contamination of components of the infusion line, with particular suspicion directed towards three-way stopcocks or other junction features. Other possible causes of positive cultures included contamination of the culture bottles during manufacturing, contamination by the skin flora at the time of skin puncture to obtain the blood sample, and/or contamination that may have occurred when introducing the blood sample into the culture bottles. Since the intravenous infusion fluids given to the 29 patients were highly varied, contamination of the

Table 3. Report from the Division of Bacteriology, Department of Clinical Laboratories

16 August 2000

The hospital personnel have been informed of the unusually high incidence of infection by *Bacillus* spp. (6 cases in July and 9 cases in August, with a total of 21 cases). Outline of the outbreak and information concerning the management of this disease are given below.

Bacillus spp. are commonly observed bacteria classified as Gram-positive rods. Although they are not virulent, they are known to be causative for food poisoning and various ophthalmic infections, and as opportunistic infections among patients who are in a state of immunodeficiency. There has been a report of nosocomial catheter sepsis caused by the *Bacillus* spp.

Bacillus spp. are spore-forming rods that are resistant to disinfectants in general (Glutaral being an exception). They are also resistant to the cephalosporins most commonly used in clinical setting, and should be treated with Tetracyclin, Minocyclin, aminoglycosides, new quinolones, and Vancomycin.

Infections due to *Bacillus* spp., unlike infections due to the virulent strains of MRSA, are rarely reported to be fatal, and adequate use of antibiotics will usually result in cure. In the wards where the microorganism was frequently detected, sufficient measures should be taken to contain the infection, including frequent hand-washing by medical personnel. Remember that the *Bacillus* spp. are relatively resistant to chemical disinfectants in general.

Head of Hospital Committee for Prevention of Nosocomial Infection

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Table 4. The results of drug sensitivity tests

Drugs[1] \ Case No	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	17	18	19
ABPC	MS	MS	S	MS	R	S	R	I	I	MS	I	I	I	I	I	I	MS	I
PIPC	MS	MS	S	S	MS	S	I	R	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
CCL	MS	MS	S	S	I	S	I	R	MS	MS	MS	MS	MS	I	MS	MS	MS	MS
CEZ	MS	S	S	R	R	S	R	R	I	MS	MS	I	I	I	I	I	I	I
CMZ	MS	MS	S	S	I	S	R	R	MS	MS	MS	MS	MS	R	R	R	MS	MS
CTM	I	I	S	R	R	I	R	R	R	I	R	R	R	R	R	R	R	I
CTX	I	I	S	R	MS	S	R	R	R	I	I	I	I	R	R	R	I	I
CAZ	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
CPR	MS	MS	S	S	MS	S	R	R	I	MS	MS	MS	MS	MS	R	R	MS	MS
FMOX	MS	S	S	S	MS	S	I	I	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
SBT/ABPC	MS	MS	S	S	MS	S	I	R	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
IPM/CS	S	S	S	S	S	S	MS	MS	S	S	S	S	S	S	S	S	S	S
AZT	R	R	MS	R	R	MS	R	R	R	R	R	R	R	R	R	R	R	R
GM	MS	MS	S	S	MS	S	MS	S	MS	MS	S	MS	MS	MS	MS	S	MS	MS
AMK	S	S	S	S	S	S	S	S	S	S	S	MS	S	S	S	S	S	MS
MINO	S	S	S	S	S	S	S	S	S	S	S	S	S	S	MS	S	S	MS
LVFX	S	I	S	S	S	S	S	S	S	S	MS	MS	MS	S	MS	S	I	MS
ST	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
FOM	S	S	S	S	S	S	S	S	S	S	S	MS	S	MS	S	S	MS	MS

[1]ABPC: ampicillin, PIPC: piperacillin, CCL: cefaclor, CEZ: cefazolin, CMZ: cefmetazole, CTM: cefotiam, CTX: cefotaxime, CAZ: ceftazidime, CPR: cefpirome, FMOX: flomoxef, SBT/ABPC: sulbactam/ampicillin, IPM/CS: imipenem/cilastatin, AZT: azthreonam, GM: gentamicin, AMK: amikacin, MINO: minocycline, LVFX: levofloxacin, ST: streptomycin, FOM: fosfomycin, MS:moderately susceptible, S: susceptible, R: resistant, I: intermediate

Table 5. Possible route of infection by the *Bacillus* spp.

Meeting of the Hospital Committee for Prevention of Nosocomial Infection
28 August 2000 (Matsumoto, Sawazaki, Hiramatsu)

A. Route of infection
  1. Infusion fluids
    1) at manufacturing — little or no possibility as a route of infection
    2) at mixing — little or no possibility
  2. Infusion lines
    1) three-way stopcocks — possible route of infection
    2) heparin lock — possible
  3. Blood culture
    1) at manufacturing of the culture bottle — little or no possibility
    2) contamination from the skin flora at puncture — possible
    3) contamination when introducing the sample into the bottle — possible
B. Origin of the *Bacillus* spp.
  1. Other infection sites of the patient — unlikely to be the origin
  2. Hands of medical personnel — possible origin
C. Prevention measures
  1. Infusion lines
    1) three-way stopcocks — reuse of caps banned since 1 September
    2) heparin locks — avoided where possible since 1 September
  2. Blood culture
    1) at the pucture site — use of sterilized gloves since 1 September
    2) when introducing the sample into the bottle — use of sterilized gloves since 1 September
  3. Hand washing — Replaced all disinfectant containers on 4 September

infusion products during manufacturing was deemed improbable.

The incidence of *Bacillus* septicemia stratified according to the wards is shown in Table 7. The bacteria were detected in 10 patients in ward 7 South, in 8 in ward 3 North, 5 in ward South 3, 2 each in wards East 6 and 7, and one each in wards South 4 and 6. Of particular note, the incidence was markedly different between ward 7 East and ward 7 South, both of which cover the department of internal medicine and house similar populations of patients in terms of underlying disease. There was no difference between the two wards in terms of incidence of use of the three-way stopcocks and/or infusion pauses with temporary heparinized lock of the intravenous lines. However, the medical personnel of ward 7 East were instructed after July to refrain from reuse of old caps after injections of medications into the lines through the three-way stopcocks. Instead, they have been trained to close the side-line by using new disposable aseptic caps each time the line is disconnected. It was also curious to find that no *Bacillus*-related septicemia was observed in wards 3 East, 4 East, and 5 East. Of these, ward 3 East is the ICU where intravenous infusion is usually uninterrupted, and involves no locking procedures using heparinized solutions. Injections of medications in this ward are given through rubber-caps and not through the three-way stopcocks with removable caps. Further, reuse of these caps had been prohibited in wards 4 East and 5 East, where infusion pauses are also rare events. These facts highlighted the likelihood of manipulation of the intravenous lines as a source of *Bacillus* infection.

From these results, the hospital committee concluded that the septicemia was largely attributable to infection through intravenous lines, and was caused primarily by manipulation of the lines by the medical personnel. Consequently, the committee decided that the medical personnel should 1) refrain from infusion pauses using heparin locks, and 2) discard the caps for the three-way stopcocks each time they were removed and replace them with new disposable caps. The

Table 6. The results of the laboratory tests for identification of the *Bacillus* spp.

Case No.	Species	Hemolysis	Carbohydrate degradation	H-antigens	Enterotoxin	Cereulide
7	Unknown	β	+	–	–	–
8	Cereus	β	+	–	+	–
9	Cereus	β	+	–	–	–
10	Cereus	β	+	17	–	–
11	Cereus	β	+	6	+	–
13	Cereus	β	+	6	+	–
14	Cereus	β	+	–	–	–
15	Cereus	β	+	–	–	–
16	Cereus	β	+	–	+	–
17	Cereus	–	+	–	–	–
18	Cereus	β	+	17	–	–
19	Cereus	β	+	–	–	–

Table 7. The incidence of *Bacillus* septicemia stratified according to the wards

Ward	Numbers of septicemia	Ward	Numbers of septicemia
S3	5	E3	0
S4	0	E4	0
S5	0	E5	0
S6	1	E6	0
S7	9	E7	0
N3	4		

Table 8. Summary of the enviromental survey regarding *Bacillus* spp. conducted in Ward 7 South

3 August 2000

Number	Working surface	Numbers of colony detected after 18 h	Numbers of colony detected after 48 h	Other bacterial species detected
1	Container for the syringes (knob)	–	–	–
2	Surface on the working table	–	1	Staphylococcus
3	Lid for the container of sterile cotton	–	–	–
4	Drinking tip of the drink feeder	–	–	Staphylococcus
5	Internal surface of the dryer	–	1	–
6	Wiping towels in use	–	1	Candida
7	Handles of the water tap in the nurse station	∞	∞	Serratia
8	Handles of the water tap in the toilet for the patient	1	2	Bacillus, Micrococcus

hospital staff were informed of these decisions at one of the regular meetings held on 31st August, and were requested to observe these rules stringently from 1st September onward.

Since the microorganisms were considered to have spread from the hands of medical personnel, attention of the hospital committee was then turned to a critical review of the method of hand washing. *Bacillus* spp. are not vulnerable to alcoholic disinfectants owing to the fact that they are spore-forming rods. This prompted the committee to proceed with an environmental survey, the results of which are shown in Tables 8 and 9. This survey was conducted in ward 7 South, because detection frequency was comparatively high in ward 7 South, where 9 patients were found to have septicemia due to *Bacillus* spp. *Bacillus* spp. were not detected from working surfaces of the nurses' station, but were detected from a tap in the patients' lavatory. With regard to the alcoholic disinfectants used by medical personnel to scrub the hands, *Bacillus* spp. were detected not from the solution itself but on the lever cap of the disinfectant containers, which is infrequently manipulated by the user to extract the solution. This prompted the committee to replace the old containers with new ones.

As a result of the preventive measures described above, the incidence of septicemia due to *Bacillus* spp. decreased considerably from the first of September, and only two new cases have been reported.

Finally, to ensure aseptic collection of the peripheral blood, medical personnel were urged to use sterile gloves and apply iodine-containing compounds to the site of puncture. Consequently, a marked decrease was observed in the incidence of detection of the microorganism in blood culture in the absence of clinical signs of septicemia.

Table 9. Environmental survey on the alcoholic disinfectants

Ward	Room number	Kind of alcoholic disinfectant	Solution itself	Lever cap of the container	Numbers of colony of the *Bacillus* spp. detected
7 South	701	Liquid	–	+	4
	702	Liquid	–	–	0
	710	Liquid	–	–	0
	712	Liquid	–	+	1
	718	Liquid	–	+	10<
	720	Liquid	–	+	4
7 East	752	Gel	–	+	10<
	755	Liquid	–	+	9
	762	Liquid	–	–	0
	765	Gel	–	+	1
	767	Liquid	–	–	0
	769	Liquid	–	–	0
	771	Gel	–	+	2
3 South	301	Liquid	–	–	0
	303	Liquid	–	+	1
	306	Liquid	–	+	5
	308	Liquid	–	–	0
	312	Liquid	–	–	0
	320	Liquid	–	+	6
3 North	363	Liquid	–	–	0
	371	Liquid	–	+	3
	377	Liquid	–	+	1
	380	Liquid	–	–	0
	381	Liquid	–	–	0

DISCUSSION

Bacillus spp. are classified as Gram-positive spore-forming rods, of which *B. anthracis* and *B. cereus* are generally known to be pathogenic to humans (10,11). *B. cereus* is commonly found in the natural environment and is occasionally responsible for food poisoning. *Bacillus* spp. are infrequently detected in blood culture, and are the cause of only a small percent of cases of septicemia. Such rare cases are observed mostly among compromised patients with severe hematological disorders (12-19).

Detection of *Bacillus* spp. in blood culture is usually interpreted as the result of contamination by the skin flora, and is assumed to be of little pathogenic significance. The extraordinarily high incidence of detection of these microorganism, as the cause of septicemia in the current series entirely contradicted this assumption. In the summer of 2000, the temperature in the Komaki district was unusually high, and was estimated to have provided an ideal environment for the growth of *Bacillus* spp., for which the optimal temperature is 30-37°C. Analysis of data obtained through the environmental survey and inquiry forms, indicated that the *Bacillus* spp. in this outbreak probably originated from the hands of medical personnel, and that transmission into the peripheral blood of patients occurred through intravenous infusion lines. Barrie et al. reported on two cases of *B. cereus* meningitis that were attributed to hospital linen heavily contaminated with *B. cereus* spores after having been laundered by a batch-continuous washing machine (20). The possibility remains, therefore, that the origin of *Bacillus* spp. may have been something other than the hands of medical personnel in some of the patients in our series. However, as a precautionary measure based on data in this investigation, in order to minimize manipulation of intravenous lines, the hospital committee for prevention of nosocomial infection abolished the reuse of removable caps for the three-way stopcocks and recommended minimizing the infusion pauses during which the lines are heparin locked. These preventive measures were strictly observed, and, consequently, the incidence of *Bacillus*-related bacteremia declined considerably. Although the air temperature declined slightly in September, the temperature during the daytime remained optimal for the growth of the microorganism, and this difference in temperature alone cannot be deemed responsible for the sudden decrease in the incidence of this uncommon disease. Further, in order to prevent nosocomial infection with microorganisms such as *Bacillus* spp. that are resistant to alcoholic disinfectants, it was recommended that chemically aseptic disinfectants continue to be used, in conjunction with a thorough procedure of washing hands under running water.

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