

FLAVOBACTERIUM MENINGOSEPTICUM IN INTENSIVE CARE UNITS OF A TEACHING HOSPITAL IN RIYADH, SAUDI ARABIA

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Flavobacterium species are a group of gram-negative, aerobic, nonmotile, nonfermentative, oxidase-positive bacilli. They usually inhabit natural fresh and salt water as well as soil,^{1,2} but are not usually part of the human normal flora.³ *Flavobacterium meningosepticum* is the species most often associated with human disease, and it was initially recognized and named by King in 1959.⁴ Besides causing meningitis in premature infants,⁵⁻⁷ the organism has previously been reported as a cause of many hospital-acquired infections, including endocarditis,⁸ postoperative bacteremia,⁹ burn and soft tissue infections,¹⁰ as well as pneumonia in patients in intensive care units.^{11,12} Some of these infections were linked to environmental sources.^{10,13} *F. meningosepticum* isolates were known for their high level of resistance to antimicrobial agents usually used in the treatment of infections due to gram-negative aerobic bacilli.^{14,15} However, they are sometimes susceptible to antibiotics active against gram-positive organisms.¹⁵

In this study, we describe a limited outbreak of *F. meningosepticum* in the intensive care units of our hospital. The importance of different clinical features in the acquisition of *F. meningosepticum*, the possible sources, methods of transmission, and control of spread of this organism are also discussed. The aim of this study was to draw the attention of hospital staff in this country to the importance of this organism as a possible cause of hospital-acquired infection in intensive care units as well as to control measures for such outbreaks.

Patients and Methods

King Khalid University Hospital (KKUH) is the main teaching hospital in Riyadh, Saudi Arabia, with 650 beds. It provides primary, secondary and tertiary health care.

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The hospital has 63 critical care beds in six different intensive care units (ICUs), including a medical (MICU) and a coronary (CCU) care unit.

Both the MICU and CCU are located with the medical wards in the third floor of the hospital. The two units, adjacent to each other, are separated only by a single door, but are serviced by different staff members. The respiratory therapists serve both units. The two units' beds are always fully occupied, with 80% to 90% of the MICU patients usually on mechanical ventilation. The infection surveillance in the ICUs is conducted by the infection control officer and two infection control nurses.

The patients' data were collected from the medical files and the daily follow-up records of the MICU and CCU patients from whom *F. meningosepticum* was isolated during the period between 11/3/95 and 4/5/95.

From each patient, the following specimens were collected for culture: blood, sputum, endotracheal secretions, bronchoalveolar lavage, urine and feces. Throat, axillary, nasal, and perineal swabs were also collected from the patients and the health care members directly involved in their management, including the respiratory therapists. Fingerprints of all involved staff were also collected on relevant culture medium plates.

For environmental screening, specimens were collected from tap water, water sink traps and spigots, nebulizing fluids, nebulizing fluid dispensers, in-use disinfectant solutions, fluids used for cleaning respiratory equipment and soap containers. Specimens from dry objects, e.g., respiratory equipment, various fomites and trolley tops were collected by using premoistened swabs. High-level and low-level settled plates were also obtained. Similar specimens from matching patients, 32 staff members and environmental sites were collected from the general adult female medical ward during the same period as the controls.

All the specimens were cultured according to methods described before¹⁶ on blood agar, MacConkey and modified Thayer Martin media and incubated aerobically at 37 °C for two to seven days. Suspicious-looking colonies were picked and identified by API 20 NE (analytical profile index, Biomerieux, France).

Disc diffusion antibiotic susceptibility was performed by the rotating Stoke's method,¹⁷ using *Pseudomonas aeruginosa* ATCC 25922 as a control. In addition, the minimum inhibitory concentration (MIC) for different antimicrobial agents was determined using a PDM Epsilon meter (E-test AB Biodisk, Solna, Sweden). The test was performed as per the manufacturer's instructions. The MIC break point resistance was interpreted according to NCCLS recommendations.¹⁸

Case 1

A 55-year-old Saudi female, known to have diabetes mellitus, hypertension and nephrotic syndrome, was admitted to the medical ward with a history of fever and chest pain for three days before admission. She was found to have bilateral crackles on chest examination and her chest x-ray revealed patchy infiltrates in both lower zones. After septic screen, including sputum culture, was done, she was started on IV ceftazidime and clindamycin in recommended doses, but she continued to have progressive hypoxemia and progressive infiltrates on chest x-ray on day 2. She was transferred to the MICU, intubated and put on mechanical ventilator. She developed acute renal failure and was started on dialysis. Her sputum culture, endotracheal tube (ETT) swab, as well as bronchoalveolar lavage done on day 22, revealed a heavy growth of *F. meningosepticum* sensitive to ciprofloxacin and she was started on IV ciprofloxacin. Results of her sputum microscopy, white blood cell (WBC) count and her temperature on day 22 are as shown in Table 1. Her repeat sputum done on day 31 revealed methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin was added. She continued to have severe hypoxemia and hypotension. A Swan-Ganz catheter was inserted and pulmonary capillary wedge pressure (PCWP) was normal. The patient continued to deteriorate and expired on day 37 of her hospitalization.

Case 2

A 62-year-old Saudi male, known to have rheumatoid arthritis with joint deformities and severe interstitial lung disease, was admitted to the medical ward with a history of fever and cough for seven days before admission. His chest examination revealed coarse crackles at both bases. After doing a septic screen, including sputum culture, he was started on cefuroxime and erythromycin IV in recommended doses. On day 30 he developed severe shortness of breath. His chest x-ray showed increasing infiltrates and his antibiotic therapy was changed to ceftazidime and flucloxacillin in recommended doses. The patient developed cardiopulmonary arrest on day 40 after admission and was transferred to the MICU. He was intubated and put on mechanical ventilation. He continued to have hypotension, requiring vasopressors.

Sputum, ETT swab, as well as bronchoalveolar lavage culture were done on day 46 and revealed *F. meningosepticum* which, when tested by disc diffusion, was found to be resistant to all antibiotics except ciprofloxacin, to which it showed moderate sensitivity. His temperature, WBC count and sputum microscopy on day 46 were as shown in Table 1. He was started on ciprofloxacin 200 mg IV twice daily. His status continued to deteriorate and he expired on day 54 of admission to the hospital.

Case 3

A 70-year-old Eritrean female, known to have bronchial asthma, duodenal ulcer and osteoarthritis, was admitted to the CCU with a history of severe retrosternal chest pain associated with vomiting and sweating of 12 hours' duration. Her electrocardiogram showed evidence of acute anteroseptal myocardial infarction. She was managed with IV heparin and glyceryl trinitrate infusions and was transferred to the medical ward on day 4. On day 8, she underwent cardiac catheterization and angioplasty. She arrested during the procedure and was revived, intubated, readmitted to the CCU and put on a mechanical ventilator. A Swan-Ganz catheter was inserted and PCWP was found to be high. She was put on positive inotropic medication and an intra-aortic balloon pump was inserted. At this time, aseptic screen, including sputum culture, was performed. The patient developed fever and hypotension with bilateral chest infiltrates on day 11 and was started on ceftazidime and clindamycin in recommended dosages. She arrested again on day 38 and day 41 and was resuscitated. She developed acute renal failure and was dialyzed.

Sputum and bronchoalveolar and ETT swab cultures done on day 58 showed a heavy growth of *F. meningosepticum* (results received after death of the patient). Her temperature, WBC count and sputum microscopy on day 58 are shown in Table 1. *F. meningosepticum* isolate was found to be moderately sensitive only to piperacillin and amikacin by disc diffusion test. Her status continued to deteriorate and she expired on day 59.

Case 4

A 55-year-old Saudi female, known to have hypertension for three years, was brought to accident and emergency (A and E) of KKUH with a history of shortness of breath for four hours. She developed cardiopulmonary arrest on arrival to A and E. She was resuscitated, transferred to MICU and put on mechanical ventilator. She was found to have acute and chronic renal failure and was started on hemodialysis. Her sputum culture on day 12 revealed *Serratia* species and she was started on IV ceftriaxone. Tracheostomy was done on day 15 to

TABLE 1. Relevant clinical data of patients from whom *Flavobacterium meningosepticum* was isolated.

Sex/age	Invasive procedures	Sputum microscopy	Total WBC*	Temperature *	OMI/source
F/55	Swan-Ganz catheter, tracheostomy, ETT	Many pus cells; gram -ve cells	8.8x10 ⁹ /L	38.6°C	MRSA/sputum
M/62	ETT	Moderate pus cells; gram -ve bacilli and gram +cocci	6.7x10 ⁹ /L	36°C	None
F/70	Swan-Ganz catheter, intra-aortic balloon pump; cardiac catheterization; angioplasty, ETT	Many pus cells, gram -ve bacilli; gram +ve cocci	13.5x10 ⁹ /L	39.5°C	<i>Candida albicans</i> /urine; group D streptococcus/sputum
F/55	Colonoscopy, gastroscopy, ETT, tracheostomy	Many pus cells; gram -ve bacilli; gram +ve cocci	11.5x10 ⁹ /L	38°C	<i>P. aeruginosa</i> /urine, sputum; group D streptococcus/urine; MRSA/urine, bed sore; <i>Serratia</i> species/sputum
F/38	Laparoscopy, forceps delivery, chest draining tube, ETT, laparotomy, cholecystostomy	Many pus cells; gram -ve bacilli	16.9x10 ⁹ /L	38°C	<i>Candida albicans</i> /urine, sputum; <i>P. aeruginosa</i> /urine, AFB, peritoneal cavity fluid; <i>Bacteroides</i> species/ blood

*At the time of isolation of *F. meningosepticum*; MRSA=methicillin-resistant *staphylococcus aureus*; ETT=endotracheal tube; AFB=acid-fast bacilli; OMI=other microbial isolates.

facilitate draining of secretions and she was weaned off the ventilator on day 22 and was transferred to the medical ward on day 27. She continued to have a low grade fever and her sputum culture on day 27 revealed a growth of *P. aeruginosa* and *Serratia* species and repeat sputum culture one week later showed a mixed growth of MRSA, *P. aeruginosa* and group *D. streptococcus*. Her antibiotics were adjusted accordingly. On day 40, her respiratory functions deteriorated to a point necessitating readmission to the MICU and artificial ventilation. Sputum culture on readmission to the MICU showed the same mixed growth of *P. aeruginosa*, MRSA and group *D. streptococcus*. On day 47, her sputum culture showed a heavy growth of *F. meningosepticum* resistant to all antibiotics except ciprofloxacin when tested by the disc diffusion method. A swab from the ETT and a bronchoalveolar lavage specimen also grew the same organism. Her temperature, WBC count and sputum microscopy on day 47 were as shown in Table 1. She was started on ciprofloxacin but continued to deteriorate and expired on day 54 of hospitalization.

Case 5

A 38-year-old Sudanese female was admitted to the medical ward with a history of fever, vomiting, loss of weight and decreased appetite for two months. She was 28 weeks pregnant and delivered a premature baby on day five of her hospitalization. Laparoscopy revealed multiple tubercles and biopsy from the tubercles confirmed the diagnosis of tuberculosis. She was started on antituberculosis treatment (rifampicin, isoniazide, pyrazinamide and ethambutol) and prednisone. On day 30, she developed shortness of breath, chest pain and hypotension and was transferred to the MICU. She was found to have bilateral lower lobar pneumonia and right

empyema and a chest tube was inserted. She continued to have fever and developed signs of peritonitis. Ultrasound of the abdomen revealed a distended gallbladder with gallstones and free fluid in the peritoneal cavity. Urgent laparotomy and cholecystectomy was done and two liters of pus was removed from the peritoneal cavity.¹ She was kept on mechanical ventilation and started on imipenem but continued to have a high grade fever. Her blood culture grew *Bacteroides* species, for which metronidazole was added. In view of the continuous fever and repeated isolation of *Candida albicans* from her sputum and urine, she was started on IV amphotericin.

On day 58, her sputum as well as the bronchoalveolar lavage and ETT swab cultures showed a heavy growth of *F. meningosepticum* sensitive to ciprofloxacin and partially sensitive to ceftazidime when tested by the disc diffusion method. Her temperature, WBC count and sputum microscopy on day 58 are as shown in Table 1. She was put on IV ceftazidime and ciprofloxacin in recommended doses. She continued to deteriorate with worsening of pulmonary infiltrates, hypoxemia and CO₂ retention. She expired on day 72 of hospitalization.²

Results

Figure 1 shows dates of admission, isolation of *F. meningosepticum* and expiry dates of the patients in the ICUs. The length of stay of the patients in the ICU ranged between 14 to 54 days with a mean of 42 days. The time between admission and isolation of *F. meningosepticum* ranged between six and 58 days with a mean of 32 days. The shortest time between isolation of *F. meningosepticum* and expiry was one day, while the longest time was 19 days with a mean of 10 days.

Some of the important clinical and laboratory data of

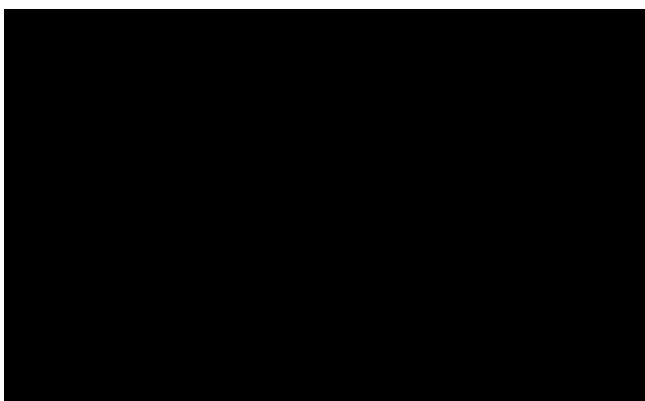


FIGURE 1. Dates of admission, isolation of *Flavobacterium meningosepticum* and expiry dates of patients in intensive care units.

the patients are shown in Table 1. All patients had mechanical ventilation for a period ranging between 14 to 48 days with a mean of 31 days. Similarly, all patients underwent respiratory therapy and some sort of invasive procedure. Also, all patients had chest crackles and showed basilar infiltrates on chest x-ray. At least one attack of myocardial infarction was experienced by patients 2, 3 and 4, while patients 1, 2 and 4 had renal insufficiency, necessitating dialysis. Major surgery was performed only on patient 5, who had a laparotomy and cholecystectomy.

F. meningosepticum was isolated from the sputum, endotracheal tube swab and bronchoalveolar lavage of all patients. Microscopy of sputum and bronchoalveolar lavage from all patients showed moderate to many pus cells and gram-negative bacilli with or without gram-positive cocci at the time of isolation of *F. meningosepticum*. All patients except patient 2 were febrile at the time of isolation of *F. meningosepticum*. Blood samples collected at this time showed a total white cell count ranging from $6.7\text{-}16.9 \times 10^9/\text{L}$ with a mean of $11.5 \times 10^9/\text{L}$. None of the patients had *F. meningosepticum* grown from blood culture samples. However, patient 5 blood culture showed a *Bacteroides* species at an earlier stage of her disease. A wide range of other microorganisms was isolated from different sites of all patients except patient 2.

All the specimens from these patients, except sputum, ETT swab and bronchoalveolar lavage, were negative for *F. meningosepticum*. Similarly, specimens from staff members managing these patients during the outbreak after the discovery of case 2, as well as control patients and staff, were negative for *F. meningosepticum*. One swab from a sink trap in the CCU, where patient 3 was managed, showed a growth of *F. meningosepticum*. This isolate showed a morphology, biochemical activity and an antibiogram similar to that of isolates from the patients.

All other environmental specimens from the intensive care units and general female medical ward were negative for *F. meningosepticum*.

The organisms were identified as *F. meningosepticum* as they grew after 24 hours as nonpigmented medium-sized colonies on blood agar plate and small colonies on MacConkey and modified Thayer-Martin plates. They were catalase- and oxidase-positive, nonmotile and appeared as short rods on Gram stain. In API 20NE, all the isolates gave excellent identification for *F. meningosepticum* no. 1042004. All were indole-positive and hydrolyse gelatin. Table 2 shows the minimum inhibitory concentration (MIC) of different antimicrobial agents against the *F. meningosepticum* isolates. Approximately all six isolates had a similar antibiogram. The slight differences seen are within accepted laboratory errors.

The Outbreak

The isolation of *F. meningosepticum* from our hospital was extremely rare before this outbreak. During the period between 1982 to 1994, only four isolates were recognized. However, over a period of two months, five isolates of *F. meningosepticum* were documented in the MICU and CCU.

The organism first appeared on 11 March 1995 from a sputum, ETT swab and bronchoalveolar lavage specimen of a patient (Case 1) suspected to have lower respiratory infection. As the isolate was multiresistant, recommended infection control measures were implemented to prevent its spread. One week later, similar specimens from another patient (Case 2) grew *F. meningosepticum* with a similar antibiogram to the previous isolate. Considering these two isolates to be similar and due to the infrequent isolation of this organism in our hospital, an investigation for its source was conducted. This included swabbing relevant sites of a total of 32 staff members involved in the management of these patients, other patients, related environmental sites and medical equipment, including the different machines used for ventilation of these patients in the MICU. No *F. meningosepticum* was isolated. Infection control measures were further emphasized. On 25 March, a patient in the CCU (Case 3), who was investigated for suspected pneumonia, had a heavy growth of *F. meningosepticum* from the sputum, ETT swab, as well as bronchoalveolar lavage specimen. This *F. meningosepticum* isolate was morphologically and biochemically similar to the previous isolates and had a slightly different antibiogram. As this patient (Case 3) was admitted to the CCU before the previous two cases, she was thought to be the probable index case. Accordingly, an investigation similar to that conducted in the MICU was undertaken. A positive result was obtained from a sink trap in the cubicle in which this patient (Case 3) was managed. The isolate of *F. meningosepticum* from this sink trap had similar

TABLE 2. Minimum concentration inhibitory (MIC) of *Flavobacterium meningosepticum* isolates.

Isolate from case 1	Ampicillin	Cefuroxim e	Ceftriaxone	Aztreonam	Ceftazidime	Piperacillin	Imipenem	Clindamycin	Vancomycin	Erythromycin	Rifampicin	Gentamicin	Amikacin	Ciprofloxacin	Trimethoprim/sulphonamide
	≥32	≥32	≥64	≥32	≥32	≥128	≥16	≥4	≥4	-8	-4	-16	-64	-4	≥4/76
1	192	256	64	256	256	8.0	32	0.5	12	2.0	0.5	256	8	0.19	2.0
2	192	256	64	256	256	8.0	32	0.5	12	1.5	0.5	256	8	0.19	2.0
3	192	256	64	256	256	8.0	32	0.5	12	1.5	0.5	256	8	0.19	2.0
4	192	256	64	256	256	8.0	32	0.5	12	2.0	0.5	256	8	0.19	1.0
5	192	256	64	256	256	6.0	32	0.38	12	2.0	0.5	256	8	0.38	1.0
6*	192	256	64	256	256	8.0	32	0.38	12	2.0	1	256	16	0.38	2.0

*Environmental isolates from a sink trap in the coronary care unit.

characters to previous isolates. As there was no personnel exchange between MICU and CCU other than respiratory therapists, those were then further screened by collecting finger impressions, axillary, throat, and perineal swabs as well as fecal specimens. None of these specimens grew *F. meningosepticum*. The next day (26 March) all three patients who at some point had *F. meningosepticum* died. Special precautions were undertaken to prevent the spread of this organism further. All patients were screened before admission to the unit and one of the infection control nurses spent most of her time in the unit to help implement infection control measures. All swabs and specimens collected from MICU and CCU patients and environmental sites during the coming three weeks were negative for *F. meningosepticum*. On 15 April, respiratory tract specimens collected from another patient (Case 4) showed a heavy growth of *F. meningosepticum* exactly similar to previous isolates. As all specimens collected from this patient during her stay in the general medical ward were negative for *F. meningosepticum*, it was strongly suspected that this patient, like the previous patients, acquired the organism in the MICU/CCU. Accordingly, the environmental screening was repeated and extended to include disinfectants and disinfectant containers. All results were negative. The patient was strictly isolated. She expired one week later. Continuous surveillance for *F. meningosepticum* was performed. On 4 May another patient (Case 5) had *F. meningosepticum* isolated from all respiratory specimens, as had the previous patients. She was isolated in the same manner until she expired on 23 May. After that, the organism was not detected again in the two units, despite thorough screening of patients, staff members and environmental sites, and the outbreak appeared to cease. In fact, from May 1995 until December 1995, *F. meningosepticum* has not been isolated from our hospital.

Infection Control Measures During the Outbreak

All the patients with positive cultures for *F. meningosepticum* were isolated either in a single room or cohorted in a single cubicle. One nurse was allocated for

each patient. Adherence to strict handwashing and disinfection using 0.5% chlorohexidine in 70% isopropyl alcohol for all staff members after any direct contact with the infected patients was emphasized. All respiratory equipment were dismantled whenever possible and cleaned thoroughly with soap and water and disinfected with 1% chlorohexidine in 70% alcohol after each day of use. Suction bottles as well as nasal suction tubes were changed daily. Nebulizing fluids, other fluids coming in contact with patients' mouth and respiratory tract, as well as disinfectants were all freshly prepared for daily use. The sink trap from which *F. meningosepticum* was isolated was cleaned daily by running hot water for half an hour and disinfected by a phenolic compound. This continued until culture results were negative.

Continuous education programs were conducted for all staff members involved in the management of these patients. Special attention was given to the respiratory therapists, who were instructed to adhere strictly to hand disinfection rules and the wearing of gloves.

Discussion

As in our study, many previous investigators reported respiratory tract colonization/infection of pneumonia due to *F. meningosepticum*.^{11-13,19,20} Like our group of patients, most of the patients reported before were under intensive care and had prolonged mechanical ventilation.^{12,13,20}

Previous investigators^{12,20} found difficulty deciding whether *F. meningosepticum* isolates were infecting or colonizing the respiratory tract. In our patients, infection by *F. meningosepticum* was ascertained by the following facts: although different colonizing bacteria, e.g., *P. aeruginosa*, were isolated from these patients at different times during their hospital stay, the only bacterial isolate common to all five patients was *F. meningosepticum*. Also, *F. meningosepticum* was isolated as the major pathogen from all respiratory tract specimens, including bronchoalveolar lavage. In addition, all five patients had clinical and radiological features of pneumonia and the sputum microscopy showed more than 25 pus cells/cm. In

the majority of patients (4/5), these findings were accompanied by a high total white cell count and a temperature of more than 37.5°C. These findings are in accordance with other investigations.¹¹ Accordingly, all our patients were treated with suitable antimicrobial agents.

In some of the previous studies, *F. meningosepticum* was traced to environmental sources.^{7,16} The organism was known to inhabit watery environments and even to resist a chlorine level of 100 mg/kg higher than that used in chlorination of municipal water supplies.¹³ Although *F. meningosepticum* was frequently isolated from the hospital environment,^{10,11} our previous routine and environmental screening for hospital-acquired infections since 1982 did not reveal this organism in our hospital environment. As in our findings, Moulin traced the incriminated pathogenic *F. meningosepticum* in his study to a leaking sink trap.¹³ Some of the environmental isolates reported before were found to have different antimicrobial susceptibility compared to simultaneously identified clinical isolates.²⁰ However, our single environmental isolate was found to have a similar antibiogram to our clinical isolates.

Although in one study⁵ *F. meningosepticum* was isolated from objects in direct contact with the patient's respiratory tract, in most studies,^{13,20} including ours, the organism was not isolated from such objects.

In his study on airway colonization by *Flavobacterium* species, Moulin¹³ used cultural, morphological and biochemical criteria together with antibiogram pattern to relate environmental and clinical isolates. Using the same criteria, our sink trap isolate could be related to our clinical isolates. This fact, together with the clustering of three cases in one week (Case 1, 2 and 3), could suggest the sink trap to be the source of our clinical isolates. This is further proved by the termination of the outbreak after repeated proper cleaning and disinfection of the sink trap. Although not proven by culture in our case, the vehicle of transmission of the organism to the respiratory tract could have been staff members' hands contaminated by splashing water from the sink, as documented by previous authors.¹³ This has been supported by the same investigators, who cultured the incriminated organisms from hands of staff members.¹³ Another possible method of transmission of this organism could be water or other fluids contaminating respiratory equipment used on these patients. Our results and suggestions are in agreement with those of Pokrywka et al.,²⁰ who, in spite of their failure to find a definite marker to prove cross-infection by *F. meningosepticum* between the patients they studied, suggested that infected patients could serve as sources of infection to other patients. This is supported in our situation by the clustering of the first three cases within a week, indicating the possibility of cross-infection between patients by attending staff members. Similar findings had been

reported before.¹³

Prolonged mechanical ventilation was previously suggested as an important factor for acquisition of *F. meningosepticum*.²⁰ This is in agreement with our findings, as all our patients from whom *F. meningosepticum* was isolated were mechanically ventilated for an average period of 31 days. Other patients in the same unit and the adjacent CCU hospitalized at the same time and ventilated for shorter periods were not colonized or infected by *F. meningosepticum*. The repeated manipulation and humidification of mechanical ventilation equipment may facilitate seeding of *F. meningosepticum* in the respiratory tract by contaminated staff hands, water or other fluids. Once seeded on the respiratory equipment, these organisms can colonize or infect the respiratory tract or invade other body sites. In the study reported by Thong et al.¹⁶ on infections due to *F. meningosepticum* in a newborn nursery, the organism was isolated from the cerebrospinal fluid of all patients and blood from three patients. Bacteremia and meningitis in neonates was also reported by other authors.⁵ *F. meningosepticum* was also previously recovered from the blood culture of some adult patients²⁰ and cerebrospinal fluid of others.²¹ In none of our patients was the organism isolated from the blood culture or cerebrospinal fluid. Although this could be due to the noninvasiveness of *F. meningosepticum* in our patients, the most likely explanation is the antibiotic treatment these patients had before the collection of blood samples.

All our patients had prolonged antimicrobial therapy, either empirically or for the treatment of other isolated pathogens. This is in accordance with previous studies.⁵ As suggested before,¹⁹ the isolation of *F. meningosepticum* from these patients may be due to the selection of highly resistant bacteria resulting from overuse of antibiotics. The high resistance seen in our isolates to β -lactam antibiotics supports this suggestion.

In accordance with reports by previous authors,²² all our isolates were susceptible to trimethoprim/sulphamethoxazole, imipenem, ciprofloxacin and rifampicin, but resistant to vancomycin. Previously suggested antimicrobial treatment of *F. meningosepticum* infections included rifampicin in combination with some of these agents.²³ In our patients, antimicrobial treatment included ciprofloxacin, either alone or in combination with other agents to which the isolates showed sensitivity by the disc diffusion method.

We conclude that *F. meningosepticum* is an unusual but important opportunistic hospital pathogen which can infect mechanically ventilated, terminal stage patients in intensive care units. The organism is usually acquired from environmental water sources. It can be transferred to the respiratory tract through contaminated medical equipment, health care team hands or contaminated water

and fluids. Patients once infected/colonized may serve as sources of infection to others and clustering of cases tends to occur. Isolation of a gram-negative, oxidase-positive, nonpseudomonal organism in an intensive care unit should raise the suspicion of *F. meningosepticum*. Proper infection control measures, including hand washing, are mandatory in order to stop cross-infection by this organism.

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