Candida Osteomyelitis and Diskitis after Spinal Surgery: An Outbreak That Implicates Artificial Nail Use

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Postoperative wound infection after laminectomy is uncommon. In February 1997, 3 patients were confirmed to have postlaminectomy deep wound infections due to Candida albicans. No similar case had been seen during the previous 10 years. The infections were indolent, with a mean time from initial operation to diagnosis of 54 days (range, 26–83 days). All patients were successfully treated. Pulsed-field gel electrophoresis revealed the Candida isolates to be identical. A case-controlled study and medical record review revealed that a single operating room technician scrubbed on all 3 infected case patients but on only 32% of the uninfected controls. The technician had worn artificial nails for a 3-month period that included the dates of laminectomy site infections, and C. albicans was isolated from her throat. She was treated with fluconazole and removed from duty. No subsequent cases have occurred during the ensuing 3 years. Artificial nails are known to promote subungual growth of gram-negative bacilli and yeast. This may be clinically relevant, and hospitals should enforce policies to prevent operating room personnel from wearing artificial nails.

Nosocomial infections due to fungi have become increasingly common in the past 2 decades. National Nosocomial Infections Surveillance (NNIS) data have shown that Candida species account for three-quarters of these infections, which are particularly prevalent in patients who are treated with broad-spectrum antibiotics, those who are immunosuppressed, and those who are chronically ill and malnourished, in particular if they are receiving total parenteral nutrition or have had gastrointestinal injury or surgery [1–4]. Most of these infections involve the urinary tract, skin, and mucous membranes, or they represent fungemia associated with indwelling iv devices. Indeed, Candida species now account for ~10% of hospital-acquired nosocomial bloodstream infections.

Nosocomial surgical site infections due to Candida species, at least those in immunocompromised hosts, have been exceedingly uncommon. Although Candida albicans is isolated from burn wound infections with relative frequency, NNIS surveillance data reported that Candida species accounted for the cause of <2% of infections of nonburn surgical sites in 1990 [4]. The recent literature, however, suggests that postoperative wound infections due to Candida species are now seen more frequently and that such infections may be transmitted to patients via the hands of colonized health care workers [5–9] in a fashion similar to that described for the transmission of Staphylococcus aureus. The epidemiology of such infections has been further clarified with the use of newer and more-sophisticated typing methods, which have clearly shown that nosocomial outbreaks of candida infection can occur as a result of the transfer of organisms from the hands of medical
personnel or from point sources associated with heavily colonized medical devices.

We report a cluster of postsurgical wound infections, the cause of which was traced to an operating room technician colonized with *C. albicans*. The wearing of artificial fingernails in the operating room was epidemiologically implicated as a contributing factor.

**MATERIALS AND METHODS**

**Clinical background.** In February 1997, 3 patients were identified as having surgical site infections due to *C. albicans* at the site of prior lumbar laminectomy. The operations had occurred up to 3 months before presentation, and isolates were identified by means of surveillance of cultures submitted to the microbiology laboratory of The Stamford Hospital, a 300-bed community teaching hospital in southwestern Connecticut. The operating room was closed to spinal surgery for a period of 25 days in February and March 1997 (figure 1), during which time an intensive investigation was undertaken. This investigation revealed a potential source for the infections, and the operating room was reopened for spinal surgery again in early March. A retrospective review of microbiology laboratory records and infection control reports for the 10 years that preceded the occurrence of the cluster was undertaken. No similar infections were uncovered.

**Outbreak investigation.** A case was defined according to the criteria of the Centers for Disease Control and Prevention (CDC) [10], as any postoperative surgical site infection that was due to *C. albicans* recovered from a patient who had undergone neurosurgery at The Stamford Hospital during the 5-month period from October 1996 through February 1997. Three such cases were detected. The control patients were neurosurgery patients without surgical site infection, who were randomly selected and matched according to type of neurosurgical procedure, to complete a case-controlled study. Concurrent controls were selected from among patients who had undergone similar types of neurosurgical procedures during the outbreak period (15 November 1996 to 18 December 1996), and retrospective controls were selected from among similar patients who had undergone procedures from January 1996 through September 1996. Clinical characteristics, operative details, and personnel involved were all recorded. Predisposing risk factors for infection also were analyzed, and operative practices were reviewed. A detailed history of personal health and work habits was obtained from the personnel that were involved in the care of all 3 case patients.

Surgical personnel were asked to provide multiple surface samples of skin and mucous membranes for culture. Specimens for nasal and throat cultures were obtained by use of a Culturette collection and transport system (BBL; Becton, Dickinson, and Company). Samples for hand cultures were obtained by vigorous agitation of both hands in 100 mL of trypticase soy broth. The broth was centrifuged at 3000 G (5000 rpm) for 5 min, and the sediment was then plated, as were all other samples, on sheep blood agar and was incubated in 5% CO2 for 18 h. Fungal isolates were confirmed to be *C. albicans* by use of the API 20C system (bioMérieux Vitek) and germ-tube formation at 35°C; they were saved on brain-heart infusion agar slants for further analysis.

*C. albicans* isolates from the 3 case patients and the suspect health care worker and random concurrent clinical isolates were subjected to pulsed-field gel electrophoresis (PFGE) with whole-cell DNA and SfiI restriction endonuclease (courtesy of Dr. Thomas Patterson, Mycology Laboratory, University of Texas Health Sciences Center, San Antonio). Isolates were designated as separate strains if they differed by ≥2 bands. Isolates with all bands in common were considered to be identical.

**Description of Case Patients**

*Patient 1.* A 64-year-old male accountant underwent an L4–5 laminectomy and disectomy on 15 November 1996. Af-

![Figure 1](https://academic.oup.com/cid/article-abstract/32/3/352/282763/3233328e2e13/353)
ter the operation, the patient developed back, left-leg, and hip pain, which slowly increased and progressed to an inability to walk. This necessitated readmission 83 days after the operation. The patient was afebrile, and although the wound was well healed, it was also tender and slightly edematous. The WBC count was 10,100 cells/mm³, the sedimentation rate was 87 mm/h, and the hemoglobin level was 11.4 g/dL. MRI and CT revealed diskitis and paraspinal and soft-tissue fluid collection.

The patient underwent debridement, lavage, and drainage of a large amount of purulent material. All cultures yielded C. albicans. The patient was treated with 1000 mg of iv amphotericin B for 4 weeks, followed by oral fluconazole therapy for 12 months. Although the sedimentation rate had fallen to <30 mm/h after 8 months, the patient continued to have persistent pain and disability. Thirteen months after the start of treatment, his sedimentation rate was 28 mm/h, his hemoglobin level was 14.0 g/dL, and he was able to resume normal activities.

**Patient 2.** A previously healthy 19-year-old female student underwent an uncomplicated L4–5 laminectomy and discectomy on 12 December 1996. Slowly progressive postoperative pain and muscle spasm led to her readmission 54 days later. MRI revealed diskitis, an epidural abscess, and deep soft-tissue fluid collection. She was afebrile, and the surgical site was well healed but mildly tender and erythematous. The sedimentation rate was 150 mm/h, the WBC count was 10,800 cells/mm³ with no shift, and the hemoglobin level was 9.2 g/dL.

The patient underwent needle aspiration of the fluid collections, followed by laminotomy, debridement, and drainage. All cultures of surgical samples yielded pure C. albicans. She was treated with 1000 mg of iv amphotericin B for 6 weeks, followed by 400 mg of oral fluconazole given daily for 12 months. She recovered completely. The sedimentation rate had fallen to 30 mm/h by 5 months after the start of treatment.

**Patient 3.** A previously healthy 37-year-old male postal worker underwent an uncomplicated L4–5 lumbar laminectomy on 18 December 1996. Slowly progressive lumbar pain and persistent numbness of the right lower extremity led to his readmission 44 days after surgery. The patient’s temperature was 38.3°C, and the surgical site was well healed but slightly tender. The WBC count was 6600 cells/mm³, and the sedimentation rate was 120 mm/h. MRI revealed deep soft-tissue fluid collection, diskitis, and osteomyelitis. The patient underwent exploration, debridement, and evacuation of 100 cc of pus from the soft tissues and the paraspinal and disk spaces. Cultures yielded pure C. albicans.

He was treated with 1000 mg of iv amphotericin B and oral 5-flucytosine for 4 weeks, followed by treatment with 600 mg of oral fluconazole given daily for 11 months. He recovered completely, except for residual numbness of the right lower extremity. The sedimentation rate had fallen to 30 mm/h within 3 months of the start of treatment.

**RESULTS**

Three patients with spinal surgical site infection due to C. albicans were identified, which represents 3 (11%) of 36 spinal surgeries performed during the 6 weeks from 11 November 1996 through 22 December 1996 (the outbreak period). Slowly progressive postoperative pain led to readmission at an average of 51 days after surgery. Copious amounts of pus were found in the soft tissue and disk spaces, and cultures of all samples yielded pure C. albicans. No significant fever or overt signs of surgical site infection were present in any patient.

A retrospective review of microbiology laboratory records, the hospital’s patient database, and infection control reports did not reveal any similar cases that had occurred in the 10 years before this cluster occurred. After the identification of the third case, the operating room was closed to spinal surgery on 6 February 1997, and a formal investigation commenced.

We reviewed charts extensively and conducted discussions with operating room personnel, microbiology laboratory technologists, infectious disease specialists, neurosurgeons, and central processing personnel. The 3 patients each underwent surgery on different dates, times of day, and days of the week. They underwent surgery in 2 different operating rooms, and 3 different surgeons were involved (1 patient was operated on simultaneously by 2 surgeons) A case-controlled study (table 1) revealed no differences in patient age, patient sex, operative time, performance of intraoperative radiography, skin preparation, use of preoperative antibiotics, preoperative antimicrobial shower, use of intraoperative medications, bone wax, cautery, type of instrumentation, microscope use, anesthetic agents, irrigation solutions, or type of sutures. Of all risk factors assessed, only exposure to 1 scrub technologist was more common among case patients than among control patients (3 of 3 case patients vs. only 8 of 25 uninfected control patients [100% vs. 32%]; P = .05, by Fisher’s exact test).

Specimens from the operating room were obtained for culture, including samples of instrument surfaces, topical thrombin, intrathecal morphine, methylprednisolone suspension, bupivacaine hydrochloride, sterile strips, bone wax, cottonoids or cotton balls, and adhesive tape. All test results were negative for C. albicans. Cultures of specimens from all involved staff members (including operating room nurses, operating room technicians, and surgeons) were also performed. Initial specimens were obtained from the nares, hands, and perineum; all tested negative for C. albicans. Cultures of operative room air samples yielded no yeast or environmental fungi.

The epidemiologically implicated health care worker was interviewed and was found to have worn artificial fingernails during the 2-month period when the 3 patients had undergone surgery. Her artificial nails had been removed 3 weeks before...
the investigation and were not available for culture. She had no significant dermatitis, periungual disease, or nail deformity on physical examination. Cultures of her throat revealed a few colonies of \textit{C. albicans}, but no yeast were isolated in cultures of hand, fingernail, periungual, naris, or vaginal samples. She was removed from duty and treated with oral fluconazole for 14 days (figure 1).

The operating room was reopened for spinal surgery on 6 March 1997, when the aforementioned health care worker was identified and removed from duty. The health care worker briefly returned to duty 1 month later but resigned shortly thereafter. No subsequent episodes have occurred during the 3 years that ensued, and, as of 2 years after the completion of treatment, the 3 patients have remained cured of their infections.

The \textit{Candida} isolates from the 3 case patients and the 6 strains of \textit{C. albicans} isolated from clinical specimens of different patients during the same time period were analyzed by means of PFGE (figure 2). The 3 isolates from case patients were all identical and differed from each of the other clinical isolates.

**DISCUSSION**

Postoperative surgical site infections due to \textit{C. albicans} are rare, and their clinical course is indolent. The lack of fever and overt signs of wound sepsis in these 3 immunocompetent patients led to protracted incubation periods before detection (average, 54 days; range, 44–90 days). Despite the lack of overt wound sepsis, large amounts of pus (>100 mL) were obtained from soft tissue and paravertebral sites during reoperation, and radiographic evidence of osteomyelitis and diskitis was present.

These protracted incubation periods made the investigation and recreation of operative events difficult. However, similar and protracted incubation periods from operation to detection were seen in a series of 8 patients with sternal site infections [6] due to \textit{Candida tropicalis} (mean incubation period, 48 days; range, 14–89 days) and in an outbreak of sternal site infections [8] due to \textit{C. albicans} (15 patients; mean incubation period, 20 days; range, 10–64 days). Prolonged treatment resulted in cure, although it took several months for the sedimentation rate to fall below 30 mm/h for our patients.

Nosocomial infections due to \textit{Candida} species from exogenous sources rarely have been reported. Outbreaks have been traced to environmental sources, such as irrigation solutions,
pressure transducers, glycerine rectal suppositories, and in-line syringe use. However, even when environmental sources can be found, health care workers, especially nursing personnel, serve as the vehicle for transmission from source to patient [5–8, 11–13]. Strausbaugh et al. [14] and others [15, 16] have found that 75% of nurses harbored yeast on their hands and that >60% of the yeast were Candida species. The resident microflora of hands is found predominantly in the palmar creases, interdigital spaces, and periungual and subungual areas. Even meticulous nail care and hand washing may not be sufficient to eliminate periungual flora [15, 17, 18]. Nail length may be unimportant, since most organisms tend to live in the proximal 1 mm of nail adjacent to the soft tissue of the fingertip [17, 19].

The role of artificial fingernails in promoting the growth of periungual and nail flora has long been debated. Several studies have shown increased periungual colonization associated with artificial nail use [18, 20], especially colonization with S. aureus, gram-negative bacilli, and yeast [21]. Subungual infections due to Candida, Aspergillus, or Pseudomonas species are well documented in patients with artificial nails. Artificial fingernails also have been epidemiologically implicated in clusters of nosocomial infection [11, 22]. For these reasons, the policies of the CDC and the Association of Operating Room Nurses (AORN) unequivocally state that artificial fingernails should not be worn in the operating room [20]. It is unfortunate that such operating room standards are usually not strictly enforced.

The ability to perform genetic fingerprinting of Candida isolates has proven useful in defining previous outbreaks of candida infection, and PFGE clearly demonstrated a clonal source of the outbreak in our 3 case patients. We were unable to recover the same strain of C. albicans from the health care worker’s fingernails, perhaps because of the long interval between the surgery and case detection and because of the removal of her artificial nails. Nevertheless, she was clearly epidemiologically implicated. Since the time of the removal of her artificial nails and her subsequent resignation, no additional episodes have occurred.

It is unclear how Candida species became inoculated into the surgical wounds. The operating room technician had no direct physical contact with the patient, and there were no known technical problems or breaches of sterile technique during any of the operations. The technician was not involved in the mixing of solutions of any sort, and no one recalled her having had any upper respiratory infection. In fact, the surgeons who were involved believed that this technologist was technically very proficient. It is tempting to implicate the process of bone wax preparation. Bone wax is delivered in sterile blocks, which are removed from the package and kneaded by the operating technician until they are soft, so that wax can easily be molded into the bone ends after laminectomy. Candida species could have been forced through microperforations in the glove, perhaps facilitated by long artificial nails with a high periungual colony count of Candida, thereby inoculating the bone wax, which was then placed into the surgical wound. Methylprednisolone (administered postoperatively to all 3 patients) may have further enhanced the pathogenic ability of Candida species.

This outbreak of surgical site infections due to C. albicans emphasizes the need to enforce policies that limit the wearing of artificial fingernails in high-risk areas, such as the operating room and also, perhaps, the critical care unit and neonatal intensive care unit, as others have suggested [23]. The outbreak further illustrates the utility of DNA fingerprinting in solving epidemiological mysteries. It is fortunate that the outbreak was restricted to 3 patients by means of a thorough investigation, employment of a case-control study, and prompt action, which included the limited closure of the operating room until the probable source of the outbreak was clarified.

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