Report on an Outbreak of Postinjection Abscesses Due to Mycobacterium abscessus, Including Management with Surgery and Clarithromycin Therapy and Comparison of Strains by Random Amplified Polymorphic DNA Polymerase Chain Reaction

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An outbreak of postinjection abscesses occurred in Barranquilla, Colombia, and was associated with local injections of lidocaine given in a single physician’s office. Over a 5-month period, 350 (18%) of ~2,000 injected patients developed localized cutaneous abscesses or cellulitis; of 210 abscess specimens that were cultured, 205 were positive for rapidly growing mycobacteria, subsequently identified as Mycobacterium abscessus. The source of the outbreak was not identified. M. abscessus could not be characterized by pulsed-field gel electrophoresis, but all isolates were identical in terms of drug and heavy metal resistance patterns and random amplified polymorphic DNA PCR profiles. We believe this is the first report of the use of this latter technique for investigation of an outbreak due to M. abscessus. Therapy with a combination of surgical excision and 3–6 months’ administration of clarithromycin was successful for 95% of 148 patients treated in this manner; in contrast, therapy was successful for less than one-third of patients treated with surgery alone or clarithromycin alone. This is the largest of the nine known outbreaks of postinjection abscesses that have occurred due to rapidly growing mycobacteria and is the first in which an effective method of therapy was demonstrated.

Nosocomial disease due to rapidly growing mycobacteria was first reported by Da Costa Cruz in 1938, when he described a patient with a postinjection cutaneous abscess [1]. Since that time nosocomial disease due to these environmental species has become increasingly important. Between 1980 and 1990, 4% of all outbreaks investigated by the Centers for Disease Control and Prevention (CDC, Atlanta) were caused by mycobacteria, most of which were rapidly growing species [2]. These organisms (named for their relatively rapid growth in culture compared with that of slower species such as Mycobacterium tuberculosis) include three major pathogenic species: Mycobacterium fortuitum, Mycobacterium chelonae, and Mycobacterium abscessus. All three have been associated with nosocomial disease, but most outbreaks have been caused by M. fortuitum and M. abscessus [3–12].

Postinjection abscesses were also the first disease due to rapidly growing mycobacteria to be recognized in epidemic form. Vandepitte et al. described an outbreak of 100 cases of postinjection abscesses, which began in 1960 in a hospital in Kinshasa, Congo [13, 14]. Since that time seven additional outbreaks of postinjection abscesses due to rapidly growing mycobacteria have been reported [3–6, 11, 12, 15] (table 1). In Barranquilla, Colombia, beginning in March 1993, the largest outbreak to date of postinjection abscesses occurred, involving 350 patients. Details of the outbreak, the clinical disease, and treatment of the abscesses form the basis of this report.

Materials and Methods

Description of the Outbreak

Beginning in March 1993, a physician practicing alternative medicine in a one-physician office in Barranquilla, Colombia, observed nodular lesions and abscesses at cutaneous sites of prior subcutaneous or intramuscular injections in patients. Initially the lesions were treated with antibiotics (cephradine or dicloxacillin) and drainage of abscesses, but they did not improve. Routine cultures were reported as negative. Patients were subsequently referred to the infectious disease section of the International Clinic, in Barranquilla, Colombia, where
Table 1. Features of the known outbreaks of postinjection abscesses due to rapidly growing mycobacteria.

<table>
<thead>
<tr>
<th>Outbreak no. [reference]</th>
<th>Reusable needles</th>
<th>Reusable syringes</th>
<th>Multidose vials</th>
<th>Agents injected</th>
<th>Skin preparation agents</th>
<th>Possible or suspected cause of outbreak</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 [13, 14]</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Multiple agents</td>
<td>N/A</td>
<td>Unknown</td>
</tr>
<tr>
<td>2 [11]</td>
<td>+</td>
<td>+</td>
<td>N/A</td>
<td>Flu vaccine</td>
<td>N/A</td>
<td>Reusable needles/syringes</td>
</tr>
<tr>
<td>3 [6]</td>
<td>-</td>
<td>+*</td>
<td>+</td>
<td>Homemade dilutions of histamine</td>
<td>N/A</td>
<td>Diluent for injections</td>
</tr>
<tr>
<td>4 [4]</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>DPTP² vaccine</td>
<td>Petroleum ether</td>
<td>Unknown</td>
</tr>
<tr>
<td>5 [5]</td>
<td>N/A</td>
<td>N/A</td>
<td>+</td>
<td>Normal saline</td>
<td>Alcohol</td>
<td>Reused bottle of saline</td>
</tr>
<tr>
<td>6 [12]</td>
<td>N/A</td>
<td>+³</td>
<td>N/A</td>
<td>Lidocaine</td>
<td>Alcohol or iodine</td>
<td>Contaminated wash water for injector</td>
</tr>
<tr>
<td>7 [3]</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>Allergen extracts</td>
<td>Reusable quat-soaked cotton balls (solution made with tap water)</td>
<td>Tap water solution used to prepare skin</td>
</tr>
<tr>
<td>8 [15]</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Adrenal extract</td>
<td>N/A</td>
<td>Contaminated adrenal extract</td>
</tr>
<tr>
<td>9 [PR]</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>Lidocaine</td>
<td>Alcohol</td>
<td>Reusable injector washed, rinsed in tap water</td>
</tr>
</tbody>
</table>

NOTE. N/A = history not available; quat = quaternary ammonium (benzalkonium chloride); + = used; − = not used.

* The same syringe was used for multiple patients, but it was not strictly reusable.

² Diphtheria, pertussis, tetanus, and polio.

³ Jet injector.

postinjection abscesses due to rapidly growing mycobacteria were diagnosed.

Case records of the physician for the preceding 5 years were then reviewed, and as many patients as possible who received injections during the outbreak period (November 1992 through March 1993) were notified. Patients with postinjection infections were identified and referred to the infectious disease section, where they provided a medical history and underwent a physical examination, with careful attention given to skin and soft-tissue structures. Cultures of the skin lesions as well as biopsies were performed for as many patients as possible. Details of the injections were obtained from the physician and his office as well as from the patients.

Tuberculin skin tests were performed by the Mantoux method, with injection of 2 units of tuberculin prepared by the National Institute of Health of Colombia. Skin tests were performed a minimum of 6 weeks after the cutaneous injections and 2 weeks after the appearance of the skin lesion. Tests were considered positive if they produced 11 mm of induration after 72 hours.

Laboratory Tests

* Cultures and acid-fast stains. Specimens for culture were obtained from patients by needle aspiration, swabbing of local drainage, or biopsy, depending on the character of the lesion. Specimens were stained for acid-fast bacilli by the Ziehl-Neelsen method. Samples were plated onto Ogawa medium, blood agar, and MacConkey agar. Positive cultures were forwarded to the mycobacteria unit of the Hospital del Niño Jesús, in Barranquilla, Colombia, for complex identification. Selected organisms were then forwarded to the Hospital Infections Program of the CDC for species identification and then to the University of Texas Health Center (UTHCT; Tyler, TX) laboratories for additional testing, including DNA fingerprinting.

* Environmental cultures were performed of specimens obtained in the physician’s office: used needles and syringes, the floor, various sink utensils, the sink, and tap water.

* Pulsed-field gel electrophoresis (PFGE). PFGE was performed on large restriction fragments generated with the infrequent cutting restriction enzymes DraI and XbaI and genomic DNA, as previously described [16].

* Random amplified polymorphic DNA PCR (RAPD-PCR). Two methods of DNA extraction were applied. After centrifugation of organisms grown in Middlebrook 7H9 culture, the cells were resuspended in Tris-EDTA (TE) buffer. Purified DNA was obtained by extraction with phenol and chloroform. DNA was also extracted by boiling the cell suspension at a density of McFarland standard 4 in TE buffer with 0.1% of Triton X-100 (Sigma-Aldrich, St. Louis) for 30 minutes. The supernatant was kept as template DNA.

Fifty µL of mixture was set aside for PCR; this contained 60 mM of Tris-HCl (pH, 9.0); 2.5 mM of MgCl₂; 15 mM of (NH₄)₂SO₄; 250 µM each of dATP, dCTP, dGTP, and dTTP; 80 ng of primer; 1 U of Taq DNA polymerase; and 2.5 µL of boiling-treated DNA or purified DNA (100 µg). Three 10-bp primers, OPA2 (TGC CGA GCT G), OPA18 (AGGTGACCG T), and OPA20 (GTGCGATCC), described by Kauppinen...
et al. [17], were used. The amplification included 40 cycles, each consisting of 1 minute at 94°C, 1 minute at 36°C, and 2 minutes at 72°C.

Histopathologic studies. Histopathologic studies were performed on the biopsy specimens. Because acid-fast stains were done on the initial microbiology specimens, only a small random sample of the biopsy specimens were subjected to tissue acid-fast stains.

Susceptibility tests. Organisms were tested against amikacin, ceftoxitin, imipenem, clarithromycin, doxycycline, ciprofloxacin, and sulfonamide by means of a broth microdilution system using cation-supplemented Mueller-Hinton broth [18]. Isolates were tested for heavy-metal susceptibility to inorganic mercury, cadmium, and arsenite by a disk diffusion method [19].

Treatment

Patients were considered for therapy if they had clinical disease consisting of cellulitis, nodules, fistulae, and/or abscesses and if the culture sample was positive on acid-fast staining and/or the culture yielded the infecting organism.

Three treatment protocols were chosen: (1) surgery only, consisting of drainage of abscesses and resection of nodules and fistulae; (2) drug therapy only, consisting of administration of clarithromycin (1 g/d for adults and 0.5 g for children who weighed <40 kg; both given as two divided doses with meals for 6 months); or (3) both surgery and drug therapy. The treatment options were explained to each patient, who was allowed to choose one of the three regimens.

Follow-up during treatment was initially twice a week and then once a week during the first month, after which it was once every 2–4 weeks for the subsequent year. Dressing changes, debridement, and follow-up cultures were done as necessary. Patients were examined on each visit and questioned about symptoms suggestive of drug-related adverse events. A patient’s treatment was considered to have failed if the lesions persisted (with no apparent change) or progressed or if new lesions appeared after 6 weeks of observation/therapy.

Results

Description of the Outbreak

The index case presented with a skin lesion in December 1992, 12 days after an abdominal injection of lidocaine. A nodule of ~1.5 cm in diameter was present. This subsequently evolved into an abscess that spontaneously drained yellowish fluid. Culture of the drainage ultimately revealed \textit{M. abscessus}.

From November 1992 through March 1993 (5 months), the physician treated ~2,000 patients with subcutaneous and/or intramuscular injections, of whom 350 (18%) reported the development of skin lesions or abscesses at the injection sites. A review of records, including those of the infectious disease section at the International Clinic, revealed that only four cases of postinjection abscesses had been identified in the preceding 5 years.

The outbreak involved a single physician who practiced alternative medicine. This practice included local injections of 2% lidocaine and occasionally of the antiinflammatory medicines piroxicam and diclofenac sodium. The injections were given either subcutaneously or intramuscularly. An average of 3–5 injections were given per patient, and the same needle commonly was used for all injections in the same patient.

The lidocaine was in multidose vials and was used to prefill syringes for multiple patients. Disposable needles and syringes were used, and the skin was prepared with alcohol. The injections were given with a reusable injector, which was cleaned intermittently with commercial soap and tap water and rinsed with tap water.

The office area included a common waiting room, two examination rooms, and three restrooms. Ambient temperature was maintained by air conditioning at about 20°C. Sinks with tap water were present in the examination rooms. The physician moved into the facilities in November 1992; the facilities were new and adjacent to an active construction site. Abscesses were incised and drained in the same two examination rooms used for giving the sterile injections.

Following an investigation of the outbreak, the use of reusable injectors and related syringes was discontinued. The outbreak promptly ceased.

Infected patients. Of the 350 infected patients, 240 were evaluated in the infectious disease section of the International Clinic. Of these, 176 (68%) were women and 64 (31.9%) were men. The patients were between 7 and 81 years of age, and nine patients were <12 years old. Most of the patients were middle or upper middle class and received injections between December 1992 and March 1993 (figure 1).

The incubation period varied from 7 to 121 days; in most cases a lesion was detected by the patient or a non-clinic physician within 30 days. The incubation period was shorter in cases of abscess or cellulitis (8–12 days). The time to recognition/diagnosis of lesions in the International Clinic averaged 3–4 months following the injection (figure 1). Twenty percent of patients reported pain and 60% reported unspecified discomfort in the affected area. Five patients had fever related to the appearance of lesions.

Most patients (168, or 70%) presented with subcutaneous nodules with a diameter of 0.5 mm to 2 cm; they were firm and occasionally fixed to the deep tissues, with hyperpigmentation. Twenty percent (48) of the patients had abscesses that drained thick yellow material or yellowish-green liquid. Five percent (12) of the patients presented with fistulas, mostly leading from abscesses but also from nodules. In the latter cases, the draining liquid was off-white or yellowish but thicker than that from abscesses. Five percent (12 patients) presented with cellulitis or an inflammatory reaction around the injection site. In 25%
isolates were submitted to the CDC, where they were identified as *M. abscessus* by standard biochemical methods [20]. Species confirmation for these isolates was subsequently done in the UTHCT laboratory by means of a recently described PCR methodology [21].

Cultures of syringes, needles, vials of lidocaine, tap water, the sink, the floor, and other objects in the environment were all negative for *M. abscessus*.

**Histopathologic studies.** Biopsies were performed on 168 (70%) of the 240 patients, of which 18 showed either granulomas or chronic inflammation, 132 showed both granulomas and chronic inflammation, and 18 did not show findings suggestive of mycobacterial disease. No caseous necrosis was noted. Acid-fast stains were performed on only 12 biopsy specimens, of which 10 were positive.

**Susceptibility tests.** The five outbreak isolates of *M. abscessus* had antimicrobial susceptibilities typical of that species [18] and had almost identical susceptibilities. The isolates were susceptible only to amikacin (MIC, 8–16 μg/mL), cefoxitin (MIC, 16–32 μg/mL), and clarithromycin (MIC, 0.125–0.5 μg/mL). They were resistant to doxycycline (MIC, >16 μg/mL), ciprofloxacin (MIC, 2–>8 μg/mL), and sulfamethoxazole (MIC, >32 μg/mL).

The five isolates of *M. abscessus* also had identical heavy metal susceptibilities. They were resistant to inorganic Hg, cadmium, and arsenite [19].

**DNA typing.** With PFGE, the DNA from the five isolates broke or lysed spontaneously and could not be evaluated (a problem previously noted with 50% of isolates of *M. abscessus*) [8, 16]. By RAPD-PCR and with the use of three primers, however, these five epidemic isolates gave easily readable DNA patterns that were identical to each other but different from those of unrelated isolates of *M. abscessus*. Identity was seen with both purified DNA and the boiling-released DNA, although the patterns with the two DNA extraction methods were different. The patterns with the epidemic isolates and two random control strains of *M. abscessus* with primer OPA-18 are shown in figure 2.

**Laboratory Findings**

**Cultures and acid-fast stains.** Culture specimens were obtained from 210 of the 240 patients: by needle aspiration in 55%, spontaneous drainage in 20%, and biopsy in 25%. It was not possible to obtain culture specimens from 30 patients, and for these patients the diagnosis was based on clinical and histopathologic examination of the lesions.

Acid-fast stains were performed on all 210 patient specimens, of which 185 (88%) were positive. The organism was recovered from 205 (98%) of the samples on Ogawa medium. It was initially identified at the Hospital del Niño Jesús in Barranquilla as belonging to the *M. fortuitum* complex. Five isolates were submitted to the CDC, where they were identified as *M. abscessus* by standard biochemical methods [20]. Species confirmation for these isolates was subsequently done in the UTHCT laboratory by means of a recently described PCR methodology [21].

Cultures of syringes, needles, vials of lidocaine, tap water, the sink, the floor, and other objects in the environment were all negative for *M. abscessus*.

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**Treatment**

Thirty-five patients were treated with clarithromycin alone. Eight patients (23%) were cured, while 27 (77%) required subsequent surgical resection. Twenty-two patients were treated with surgical resection alone. Seven patients (32%) were cured, while 15 (68%) had disease progression/recurrence that required additional surgery and clarithromycin therapy for 6 months.

One hundred forty-eight patients were treated with surgical resection combined with clarithromycin therapy. Sixteen patients (11%) had complete resolution within 2 weeks of therapy, and 79 (53%) had no lesions within 3 months of therapy. Only eight patients (5%) required additional surgery after the
Figure 2. RAPD-PCR profile of five epidemic isolates of M. abscessus, obtained by two methods of DNA extraction and primer OPA-18. Lanes 1–7 contain the band patterns from the five epidemic strains (lanes 1–5) and two unrelated control strains (lanes 6 and 7), with DNA extracted with phenol and chloroform, while lanes 8–14 contain the band patterns from the same five epidemic strains (lanes 8–12) and unrelated controls (lanes 13 and 14), with DNA extracted by boiling for 30 minutes; lane 15 = commercial linear DNA standards.

6 months of therapy. One hundred forty patients (95%) were treated successfully (i.e., lesions cleared with no additional need for surgery). A summary of the three treatment regimens is provided in table 2.

The remaining 35 patients did not participate in the treatment trial and received no therapy. Ten patients’ disease appeared to spontaneously resolve, while the remaining 25 patients had persistent disease.

Clarithromycin was well tolerated: 92.5% of patients reported no major adverse events, 4.5% reported nausea or dyspepsia but continued taking the drug, and 3% discontinued the therapy because of nausea, vomiting, constipation, and/or a metallic taste in the mouth. Two patients developed abnormalities of liver function but continued taking the drug. One hundred twelve patients (70%) completed 6 months of therapy, 32 (20%) completed 3 months of therapy, and 16 (10%) completed <3 months of therapy. Premature withdrawal of the drug usually was due to a good clinical response and/or a patient’s belief that additional therapy was not needed.

Discussion

This is the largest outbreak to date of postinjection abscesses due to rapidly growing mycobacteria. The size of the outbreak may reflect the large number of patients receiving injections, the longer incubation period than for most bacterial infections, difficulty in identifying the mycobacterial pathogen, or lack of knowledge of the rapidly growing species (with regard to where they normally reside and what activities carry a risk of disease transmission).

As with all but two [12, 15] of the previous eight postinjection outbreaks due to rapidly growing mycobacteria [3, 6, 11–14] (table 1), and one outbreak that involved electromyography needles [10], the environmental source in this outbreak and exactly how it spread are unknown. Recent studies of nosocomial outbreaks due to rapidly growing mycobacteria have almost universally implicated tap water [7–10] or distilled water [12] as the source of the organism. The organism is relatively chlorine-resistant and grows well and survives at relatively high concentrations in tap water [4] and distilled water [22].

More than 50% of analyzed tap water samples from dialysis centers throughout the United States contained mycobacteria, with rapidly growing species being the most common [23]. With most of the outbreaks the water had been assumed to be sterile and was used to rinse previously sterilized medical equipment or to prepare solutions for sterilizing the skin or medical equipment.

Table 2. Summary of treatment for 240 patients with Mycobacterium abscessus postinjection abscesses.

<table>
<thead>
<tr>
<th>Treatment group</th>
<th>No. of patients evaluated</th>
<th>Results of treatment: no. (%) of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Clarithromycin alone*</td>
<td>35</td>
<td>Cure 8 (23) Failure 27 (77)</td>
</tr>
<tr>
<td>2: Surgery alone</td>
<td>22</td>
<td>Cure 7 (32) Failure 15 (68)</td>
</tr>
<tr>
<td>3: Surgery plus clarithromycin*</td>
<td>148</td>
<td>Cure 140 (95) Failure 8 (5)</td>
</tr>
<tr>
<td>4: No treatment</td>
<td>35</td>
<td>Cure 10 (29) Failure 25 (71)</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>Cure 165 (69) Failure 75 (31)</td>
</tr>
</tbody>
</table>

* For adults, 1 g/d, and for children, 0.5 g/d, given in two divided doses for both.
In the current outbreak, tap water and a nonmedical soap were used to clean the reusable injector used for injections, making it a potential source of contamination. This same reusable injector also may have helped continue the outbreak, as contamination could have occurred when it was used to administer local anesthesia for incision and drainage in patients who had already developed the infection. The reuse of the same needle in individual patients and the use of the reusable injector syringes in multiple patients also increased the risk of patient-to-patient transmission.

Treatment of postinjection abscesses in the past have generally been unsuccessful. In several studies the mean duration of the lesions was 9–12 months [5, 6, 11], with frequent recurrence after surgical resection alone [11]. In the current study, among the patients who received treatment with surgical drainage and administration of clarithromycin, the treatment success rate was >90% (table 2). However, this was not a randomized trial, and because the patients were allowed to select which treatment they received, we cannot exclude a potential bias of the results; for instance, the different types of disease (cellulitis vs. abscess) and those with more severe disease may not have appeared in equal numbers in each treatment arm.

Surgical debridement remains an important therapy for patients with disease due to rapidly growing mycobacteria, especially those with extensive disease, necrosis, or abscesses. This study reinforces the importance of this therapy. Although clarithromycin has been shown to have low MICs in vitro [24] and to be excellent as therapy for infection with the closely related species M. chelonae [25], only five patients reported to date have been treated with clarithromycin for M. abscessus infection [26, 27]. This study clearly defines the utility of this new macrolide in therapy against this rapidly growing species. Doses of 500 mg twice daily for 6 months, the same as recommended for M. chelonae infection, have generally been proven adequate for disease due to M. abscessus [26], including the current cases. Even shorter courses (perhaps for 3 months) would be adequate for a good clinical response when surgical resection is performed.

Rapid diagnosis, satisfactory treatment, and the intact immunity of the patients prevented systemic spread of the infection. However, there was a high degree of morbidity, including permanent scarring due to the multiple surgical procedures required, a complication noted in other postinjection disease outbreaks [5].

This is the first outbreak due to rapidly growing mycobacteria in which the isolates were compared with use of RAPD-PCR, also known as arbitrary primer PCR. This technique has been used with bacterial species [28, 29] as well as Mycobacterium malmoense [17], M. tuberculosis [30], and paired treatment isolates of M. chelonae and M. abscessus with clarithromycin resistance [31]. The patterns with RAPD-PCR are highly method-dependent, but the strain comparison results are almost always the same. Such were the findings with the currently studied strains. This technique is especially useful for M. abscessus, as previous studies have shown that ~50% of unrelated isolates of this species show lysis of the genomic DNA with preparation [16, 31] and cannot be tested by the large-restriction-fragment method of PFGE.

Heretofore, PFGE has been the only quality method available for comparing strains of rapidly growing mycobacterial species [8, 9, 16, 32]. RAPD-PCR may allow easy comparison of larger numbers of strains, since it is technically much simpler than PFGE and should allow testing of all strains. More experience with the technique is needed, however, and studies are needed to determine if a difference exists in the discriminatory power of the two techniques.

Acknowledgments

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References