Systematic review of nondermatophyte mold onychomycosis: Diagnosis, clinical types, epidemiology, and treatment

Aditya K. Gupta, MD, PhD, FAAD, FRCP(C),a,b Chris Drummond-Main, MSc,b Elizabeth A. Cooper, BSc, BESc,b William Brintnell, PhD, b Bianca Maria Piraccini, MD, PhD,c and Antonella Tosti, MDd

Toronto and London, Ontario, Canada; Bologna, Italy; and Miami, Florida

Nondermatophyte mold (NDM) onychomycosis is difficult to diagnose given that NDMs are common contaminants of the nails and of the mycology laboratory. Diagnostic criteria and definition of cure are inconsistent between studies, which may affect the quality of published data. We identified 6 major criteria used in the literature: identification of the NDM in the nail by microscopy (using potassium hydroxide preparation), isolation in culture, repeated isolation in culture, inoculum counting, failure to isolate a dermatophyte in culture, and histology. Most studies used 3 or more of these (range = 1-5). We recommend using at least 3 of the criteria to rule out contamination; these should include potassium hydroxide preparation for direct microscopy and isolation of the organism in culture. We review geographic distribution and clinical presentations associated with different NDMs. The treatment with the greatest quantity of data and highest reported cure rates is terbinafine, for the treatment of Scopulariopsis brevicaulis and Aspergillus species infections. Topicals such as ciclopirox nail lacquer may also be effective (data originating from Scopulariopsis brevicaulis and Acremonium species infections), especially when combined with chemical or surgical avulsion of the nail. We recommend that future studies use (and clearly indicate) at least 3 of the main criteria for diagnosis, and report the clinical type of onychomycosis and the isolated organism. When evaluating different treatments, we suggest that authors clearly define their efficacy outcomes. (J Am Acad Dermatol 2012;66:494-502.)

Key words: Aspergillus species; clinical type; diagnosis; epidemiology; nondermatophyte mold; onychomycosis; organism; Scopulariopsis brevicaulis; treatment.

Nondermatophyte molds (NDMs) account for approximately 10% of onychomycosis worldwide with the majority of onychomycoses being caused by dermatophytes and yeasts. Because of the relatively rare occurrence of this subtype of onychomycosis, studies describing the associated clinical presentations, epidemiology, and best treatment strategies are limited. Adding to the challenge is a lack of consistency between studies as to the criteria used to diagnose NDM onychomycosis, and the definition of cure. The aim of this article is to highlight the issue of proper diagnosis, while identifying accurately diagnosed, confirmed cases from which to draw conclusions regarding clinical presentation, epidemiology, and best treatments currently available for NDM onychomycosis.

DIAGNOSIS OF NDM ONYCHOMYCOSIS

To determine how NDM onychomycosis is diagnosed, a PubMed search was performed using the terms “nondermatophyte,” “onychomycosis,” “mold,” “toenail,” and spelling variations thereof. We also examined the reference sections of the
identified articles for any applicable studies that our initial search missed. Excluded were non-English-language articles, case reports, articles not readily retrievable online, in vitro studies, and clinical studies on special populations including diabetics, immunosuppressed individuals, the elderly, and young children.

We identified 6 main criteria used to diagnose NDM onychomycosis. These included identification of the NDM in the nail by microscopy (using potassium hydroxide [KOH] preparation), isolation in culture, repeated isolation in culture, inoculum counting, failure to isolate a dermatophyte in culture, and histology. Table I lists, by study, the criteria that were explicitly indicated as requirements for the diagnosis of NDM onychomycosis.

The majority of studies stated at least 3 criteria, the most common of which were isolation in culture, KOH, repeated isolation, and dermatophyte exclusion. Inoculum counting was used somewhat less and histology infrequently. A description of the various criteria follows.

Visual identification
One of the most widely applied criteria for diagnosing NDM onychomycosis is visual identification of fungal elements upon microscopic examination (positive direct microscopy). Although the vast majority of studies use a preparation containing 5% to 40% KOH for microscopic observation of nail samples or scrapings, sodium sulfide9 or sodium hydroxide10 may be substituted. In addition, Parker’s blue-black permanent ink (Parker Pen Company, Newhaven, UK)11,12 or fluorescent agents9 may be added to enhance visualization. Although KOH preparation provides a rapid screening test for fungi, and may even assist in their identification,13,14 it can be associated with false-negative results,15,16 and does not demonstrate viability or causative nature of the isolated fungal elements.17

Fungal culture
To confirm a diagnosis of NDM onychomycosis based on clinical presentation and positive direct microscopy, a demonstration of the viability of visualized fungal elements is almost always required. The majority of studies use Sabouraud dextrose agar (SDA), with supplementary antibiotics to prevent the growth of bacteria, as a medium for the culture of fungi from nails. SDA does not select among NDMs, dermatophytes, and yeasts; therefore, NDMs may overgrow the slower-growing dermatophytes and yeasts when seeded in this medium. SDA with cycloheximide added to inhibit growth of NDMs is therefore often used in parallel with SDA containing chloramphenicol and gentamycin where dermatophyte identification is essential. Cultures are grown for a period ranging from 7 days to 6 weeks, at temperatures between 25°C and 37°C. The resulting colonies are identified by microscopic and macroscopic details, according to identification keys.11 Although fungal culture demonstrates viability and allows the identification of isolated fungi, it is time-consuming, may be associated with a high rate of false-negative results,9,18 and does not distinguish causative agents from contaminants.

Dermatophyte exclusion
When Walshe and English19 first published their criteria for the diagnosis of NDM onychomycosis, they required the absence of any dermatophyte growth in cultures from nail samples in order to diagnose NDMs as pathogens. Today, caution remains in assigning origin to NDMs, given that many of the NDMs that do cause onychomycosis more frequently occur as innocuous contaminants of the feet and nails and as laboratory contaminants. Dermatophyte exclusion is used by the majority of studies in diagnosing NDM onychomycosis (Table I).

Repeated sampling
Consistent isolation of an NDM species from a series of samples increases the likelihood that the organism is a true pathogen, considering that contaminant fungi are not likely to be consistently isolated. Studies using this method vary with regard to sampling interval (1 or 2 weeks) and the number of repeated samplings (at least 2, or at least 3). Predating inoculum counting, repeated isolation is used more frequently, especially after the publication by Gupta.
et al\textsuperscript{20} that discredited the traditional 5 in 20 inoculum count.

**Inoculum counting**

Inoculum counting, proposed by Walshe and English,\textsuperscript{19} is a method aimed at distinguishing fungal contaminants from true pathogens in a single visit. It involves plating a predetermined total number of nail fragments in culture. When a predefined number of inocula grow the same fungal species, the species is presumed to be causative of the onychomycosis infection. The criteria of Walshe and English\textsuperscript{19} presumed that a species grown from at least 5 of 20 fragments was a true pathogen, provided that compatible filaments were also seen in direct microscopy of the nail samples, and that no dermatophytes grew in cultures seeded from those samples. Most studies using this criterion continue to state a requirement of 5 or more inocula, although the number of seeded nail fragments is frequently omitted. The presumption that 5 inocula is sufficient to diagnose a pathogen was tested empirically by Gupta et al\textsuperscript{20} by using successive-isolation procedures to verify actual NDM infections in untreated patients who were repeatedly followed up. The authors determined that although a count of 4 colonies of 15 seeded nail fragments (correlating with the Walshe and English\textsuperscript{19} 5 of 20 [25%]) was only predictive of true NDM onychomycosis 23.2% of the time, the rate increased to 89.7% for counts of 15 of 15 (in cases with positive direct microscopy).

**Histology**

Given that KOH preparation and fungal culture are associated with false-negative results,\textsuperscript{9,15} and culture results may take several weeks, histology may be used as an alternative method for diagnosis,\textsuperscript{15} especially when clinical suspicion of onychomycosis coincides with negative results from KOH or culture.\textsuperscript{21} The technique uses periodic acid-Schiff staining (stains glycogen and mucoproteins in the fungal cell wall)\textsuperscript{21} in combination with sectioning. Histology was found by one study to be significantly more sensitive than KOH or culture alone,\textsuperscript{15} and has

### Table I. Nondermatophyte mold diagnostic criteria used by different studies

<table>
<thead>
<tr>
<th>Visual identification (KOH)</th>
<th>Isolation in culture</th>
<th>Dermatophyte exclusion</th>
<th>Repeated isolation</th>
<th>Inoculum counting</th>
<th>Histology</th>
<th>Total</th>
<th>Year</th>
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<tr>
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<td>-</td>
<td>5</td>
<td>2005 \textsuperscript{13}</td>
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<tr>
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<td>+</td>
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<td>+</td>
<td>-</td>
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<td>+</td>
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<td>+</td>
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<td>+</td>
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<td>+</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
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<td>-</td>
<td>-</td>
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<td>4</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>4</td>
<td>1966 \textsuperscript{19}</td>
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<tr>
<td>-</td>
<td>+ (Or histology, or both)</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+ (Or culture, or both)</td>
<td>3</td>
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<td>+</td>
<td>-</td>
<td>3</td>
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<tr>
<td>+ [(KOH and culture) OR inocula counting]</td>
<td>+ [(KOH and culture) OR inocula counting]</td>
<td>+</td>
<td>+ (Or (KOH and culture))</td>
<td>-</td>
<td>2</td>
<td>1995 \textsuperscript{18}</td>
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<td>+</td>
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<td>+</td>
<td>+ (If KOH positive and culture negative)</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2002 \textsuperscript{17}</td>
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<td>-</td>
<td>-</td>
<td>2</td>
<td>1992 \textsuperscript{7}</td>
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<tr>
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<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1996 \textsuperscript{5}</td>
</tr>
</tbody>
</table>

KOH, Potassium hydroxide.

*Represents minimum number of criteria study may have used, in cases where there was any ambiguity.
†Used, but not specified as criterion.
the advantage of reliably demonstrating whether a fungus is invasive or merely colonizing subungual debris. The disadvantage of histology is that, as with KOH, it does not identify the putative pathogen.21 Furthermore, the technique is more labor-intensive and costly than KOH and culture.

Molecular biology

Traditional diagnostic techniques have shortcomings that can delay initiation of treatment for onychomycosis.

Polymerase chain reaction (PCR) is a molecular biological technique with wide use in scientific research and diagnostic medicine. In diagnosing onychomycosis, PCR can be used to rapidly amplify small amounts of fungal DNA isolated directly from clinical samples. Analysis of these amplified DNA fragments allows highly specific, and even quantifiable identification of fungal species present in the original sample through quantitative PCR, sequencing of PCR amplification products, or restriction fragment length polymorphism digestion analysis of those products.

Although these molecular techniques are more sensitive and produce results much more rapidly than traditional culture methods (24 hours as opposed to weeks or even months), they require specialized laboratory equipment and expensive reagents. In addition, PCR-based molecular techniques are limited in that they can only amplify DNA present in the original sample, and therefore cannot differentiate causative agents from contaminants, or determine viability of identified organisms. Care must therefore be taken to ensure proper sampling technique, and results must be interpreted with caution. Repeated analyses may be warranted to confirm the presence of identified fungi.

Summary

At the moment, traditional mycology remains the gold standard for diagnosing NDM onychomycosis. This includes obtaining positive results from KOH and culture. Repeated isolations (2 or 3) in the absence of a dermatophyte increase the probability of accurate identification of the causative NDM. Although inoculum counting has been used with the intention of establishing the causative NDM in a single visit, there remains controversy over the number of inocula required to confirm the causative diagnosis. The use of histopathology can be of assistance in establishing the penetration of the NDM into the nail plate, however this method cannot provide identification of the organism. Molecular biology techniques can help to establish the identification of the NDM in a time frame that is shorter than traditional culture methods; however, this methodology has not yet reached the stage of routine use in clinical practice. Overall, we recommend using at least 3 of the main diagnostic criteria outlined above, to increase the probability of accurate diagnosis.

NDMS AND CLINICAL TYPES OF ONYCHOMYCOSIS

Clinical types of onychomycosis in general (including those caused by dermatophytes and yeasts) have been described by Zaias22 and updated by Baran et al.23,24 The main types are distal and lateral subungual onychomycosis (DLSO), superficial white onychomycosis (SWO), proximal subungual onychomycosis (PSO), endonyx onychomycosis, and total dystrophic onychomycosis.25 Confirmed cases of NDM origin have been reported for DLSO, SWO, and PSO.

DLSO as a result of NDMs resembles that caused by dermatophytes, but is often associated with periungual inflammation. Acremonium species DLSO typically presents with one to two thin longitudinal white streaks located in the middle of the nail (Fig 1).

SWO caused by NDMs can be indistinguishable from that caused by dermatophytes (Fig 2), or may appear as a “deep” SWO,25 where nail plate invasion is deep and involves a large part or all of the nail (Fig 3).

PSO caused by NDMs involves proximal nail plate discoloration that may be associated with periungual inflammation (Fig 4), sometimes with purulent discharge.
To determine the prevalence of various NDMs in each clinical type of onychomycosis, we reviewed the literature for studies detailing both the causative agent and clinical presentation in confirmed cases (using at least 3 diagnostic criteria) of toenail NDM onychomycosis. Using an initial PubMed search with the terms “nondermatophyte,” “non dermatophyte,” “mold,” “mould,” and “onychomycosis,” we subsequently selected for studies involving multiple cases, using clearly stated NDM-specific diagnostic criteria to identify pathogenic molds. The reference sections of these articles were also examined for any additional suitable studies. In total, we identified 5 studies that fit our criteria.11,26-29 These included cases of DLSO, SWO, and PSO. There were no cases of total dystrophic onychomycosis or endonyx onychomycosis reported, both of which are rare. Reports of endonyx may also be limited by the fact that it is a relatively newly described type, and may be associated with *Trichophyton soudanense.*30 Any data that were ambiguous as to the causative agent, clinical type of onychomycosis, or localization of the infection (finger vs toe) was excluded from our assessment.

In total, we identified 151 cases of toenail NDM onychomycosis of known causative agent and clinical type. These were pooled, grouped by genus, and tabulated according to clinical type (Table II).

In DLSO caused by molds, 4 major agents were responsible for 88.6% of cases. These were *Scopulariopsis brevicaulis* (n = 27 [30.7%]) (Fig 5), *Aspergillus* species (n = 23 [26.1%]), *Acremonium* species (n = 15 [17.0%]), and *Fusarium* species (n = 13 [14.8%]).

In SWO caused by molds, 3 major agents accounted for 97.9% of cases. These organisms were *Acremonium* species (n = 21 [44.7%]), *Aspergillus* species (n = 12 [25.5%]) (Fig 2), and *Fusarium* species (n = 13 [27.7%]) (Fig 3).

NDM causes of PSO were only addressed in a single study,26 which implicated *Scopulariopsis brevicaulis* (n = 10 [62.5%]) and *Aspergillus* species (n = 6 [37.5%]) (Table II).

### EPIDEMIOLOGY

To investigate the epidemiology of NDM onychomycosis, we performed a PubMed search for...
English-language articles containing the terms “onychomycosis” and “epidemiology” published in the past 15 years. This approach identified more than 250 articles that were subsequently screened for data pertaining to NDMs, and for having used at least 3 clearly stated diagnostic criteria to identify pathogenic molds. Finally, articles that were selective for particular organisms or clinical presentations were excluded. In total, 9 studies published between 1997 and 2006, spanning 4 continents, were assessed. \textsuperscript{11,13,31-37} For each study, the number of reported toenail infections caused by each genus of mold is provided in Table III.

The top 5 organisms in terms of published confirmed isolations worldwide are (in descending order) \textit{Scopulariopsis brevicaulis}, \textit{Fusarium} species, \textit{Aspergillus} species, \textit{Scytalidium dimidiatum}, and \textit{Acremonium} species. In South America, studies suggest that \textit{Fusarium} species may be the most common NDM. In the European countries, the most commonly recovered species are \textit{Scopulariopsis brevicaulis}, \textit{Aspergillus} species, \textit{Acremonium} species, and \textit{Fusarium} species. \textit{Scytalidium dimidiatum} has been reported from several countries, with many of the cases being from Thailand. In some countries, the prevalence of NDMs may be higher than in North America. For example, in Thailand, one report indicated that the majority of onychomycoses were caused by NDMs (\textit{Scytalidium dimidiatum} and \textit{Fusarium} species). \textsuperscript{31}

**Treatment**

To identify articles containing data on the treatment of various NDMs causing onychomycosis, a PubMed search was performed using the terms “nondermatophyte,” “mold” (and spelling variations thereof), “onychomycosis,” and “treatment.” From the resulting articles we identified studies that clearly indicated using at least 3 of the major diagnostic criteria to accurately identify pathogenic molds. These articles were required to indicate the pathogenic organism, treatment provided, and therapeutic outcome. This approach yielded 6 studies containing data that were suitable for our assessment. \textsuperscript{26,28,38-41} Among these articles were 152 cases of toenail NDM onychomycosis including 92 caused by \textit{Scopulariopsis brevicaulis}, 44 caused by \textit{Aspergillus} species, 10 caused by \textit{Acremonium} species, 4 by \textit{Fusarium} species, two by \textit{Alternaria} species, and one by \textit{Onychocola canadensis}. Complete cure was the investigated therapeutic outcome used in our study, defined as both mycological and clinical cure. Only 3 of the studies defined mycological and clinical cure.\textsuperscript{28,38,40} All 3 defined mycological cure as negative direct microscopic examination (KOH) and negative culture, and clinical cure as a clinically normal nail. Follow-up periods ranged from 0 to 10.5 months.

The limited number of treated cases that were identified through this approach highlight the paucity of data on treatment of NDMs while at the same time providing clues as to best treatments for different organisms.

Regarding \textit{Scopulariopsis brevicaulis} infections, there is evidence supporting the efficacy of itraconazole pulse (400 mg/d for 1 wk/mo) therapy and daily terbinafine (250 mg/d), with 24 of 32 and 12 of 14 complete cures, respectively. Although efficacy has been demonstrated with daily ketoconazole (200 mg/d for 4 months) and daily fluconazole (150 mg/d for 12 weeks), 8 of 12 complete cure rate for each, ketoconazole cannot be recommended as a first-line treatment because of the potential for serious hepatic effects. Topical ciclopirox produced complete cure in 5 of 6 cases. Less evidence supports the use of long-term daily terbinafine (250 mg/d for up to 48 weeks; one of two achieved effective therapy) and topical terbinafine after chemical avulsion (one of 3 patients achieved complete cure). Griseofulvin (600 mg two times daily for 12 months) was ineffective in the management of \textit{Scopulariopsis brevicaulis}, curing none of the 11 infections that were treated. This was an expected result given the drug’s low cure rates in dermatophyte onychomycosis and narrow spectrum of activity that excludes NDMs.

In cases of \textit{Aspergillus} species infection (Figs 3 and 4), the treatment with the most evidence of efficacy was terbinafine pulse (500 mg/d for 1 wk/mo), which provided complete cure in 30 of 34 cases. Daily itraconazole (200 mg/d for 6-12 weeks and 100 mg/d for <20 weeks) produced complete cure in two of two and one of one cases, respectively. Itraconazole pulse therapy (400 mg/d for 1 wk/mo), provided complete cure in 4 of 7 cases.

In cases of \textit{Acremonium} species infection, topical terbinafine after chemical avulsion was effective in

**Fig 5.** Onychomycosis caused by \textit{Scopulariopsis brevicaulis}.
two of two cases. Daily oral terbinafine (250 mg for 3-4 months) provided complete cure in one of two cases, and topical ciclopirox yielded 2 of 3 complete cures. Pulse itraconazole (400 mg/d for 1 wk/mo) was ineffective in the 3 cases in which it was used.

In cases of infection caused by *Fusarium* species, itraconazole pulse therapy (400 mg/d for 1 wk/mo) provided complete cure in two of two cases treated, itraconazole daily therapy (200 mg for 6-12 weeks) resulted in complete cure in the one case where it was investigated, and daily oral terbinafine (250 mg/d for 3-4 months) produced no mycological or clinical cure in the single case that it was used to treat.

With regard to *Onychocola canadensis* infections, only a single confirmed, treated case was reported; treatment by itraconazole pulse therapy (400 mg/d, 1 wk/mo for 6 months) provided mycological, but not clinical cure in this case.

Overall, the treatments with the greatest amount of efficacy data are oral terbinafine and itraconazole, both of which have shown efficacy in treating *Scopulariopsis brevicaulis* and *Aspergillus* species infections. A smaller amount of data support the use of oral fluconazole and ketoconazole for treating *Scopulariopsis brevicaulis*. Our data do not support the use of griseofulvin for treating NDM onychomycosis. The limited data on ciclopirox suggest that it may be effective in treating *Scopulariopsis brevicaulis* and *Acremonium* species infections. Systemic and/or topical therapy combined with periodic chemical or surgical nail debridement/avulsion may be the best option in the management of NDM onychomycosis.

**DISCUSSION**

Onychomycosis caused by NDMs provides clinicians with a greater diagnostic challenge than does dermatophytic onychomycosis. Although the latter can be diagnosed by a single isolation of a dermatophyte, NDM onychomycosis requires further measures for confirmation. These include positive KOH in conjunction with dermatophyte exclusion. Repeated isolations and/or inoculum counting can increase the probability of accurate identification. Although molecular diagnostic approaches enable the specific identification of NDMs, they are currently in the developmental stage and have yet to be widely implemented in diagnostic laboratories.

Regarding clinical presentation, the most frequent form of NDM onychomycosis is DLSO, followed by SWO and less frequently PSO. DLSO caused by NDMs resembles that caused by dermatophytes, but is often associated with periungual inflammation. SWO caused by NDMs can be clinically indistinguishable from that caused by dermatophytes, but more often appears as a deep SWO, where nail plate invasion is deep and involves a large part of or the entire nail. PSO caused by NDMs is often recognizable because of the marked periungual inflammation, sometimes with purulent discharge, associated with proximal nail plate discoloration. Although common agents of both DLSO and SWO include *Aspergillus* species, *Acremonium* species, and *Fusarium* species, *Scopulariopsis brevicaulis* may be a common cause of DLSO but not SWO. The limited data available on PSO caused by NDMs implicate *Scopulariopsis brevicaulis* and *Aspergillus* species.

Epidemiologically, the top 5 organisms in terms of published confirmed isolations worldwide are (in descending order) *Scopulariopsis brevicaulis*, *Fusarium* species, *Aspergillus* species, *Scytalidium dimidiatum*, and *Acremonium* species. Although the data are limited, they do suggest certain trends. In South America, *Fusarium* species may be the most common NDM. In the European countries, *Scopulariopsis brevicaulis*, *Aspergillus* species, *Acremonium* species, and *Fusarium* species have been isolated most frequently. *Scytalidium dimidiatum* has been reported in several countries, with many of the cases being from Thailand. Although future studies will make trends more apparent, we

**Table III. Nondermatophyte mold isolations according to country**

<table>
<thead>
<tr>
<th>Country</th>
<th>Canada</th>
<th>Brazil</th>
<th>Colombia</th>
<th>Spain</th>
<th>Italy</th>
<th>Greece</th>
<th>Turkey</th>
<th>Pakistan</th>
<th>Thailand</th>
<th>Total</th>
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</thead>
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<td>29</td>
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<tr>
<td><em>Acremonium</em> species</td>
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<td>3</td>
<td>—</td>
<td>—</td>
<td>10</td>
<td>2</td>
<td>1</td>
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<td>18</td>
<td>—</td>
</tr>
<tr>
<td><em>Nattrassia mangiferae</em></td>
<td>—</td>
<td>4</td>
<td>—</td>
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<td>4</td>
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<tr>
<td><em>Alternaria</em> species</td>
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<td>—</td>
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<tr>
<td>Total</td>
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<td>13</td>
<td>16</td>
<td>2</td>
<td>43</td>
<td>43</td>
<td>7</td>
<td>9</td>
<td>17</td>
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</table>

Single isolations of *Paecilomyces* species, *Penicillium* species, and unknown species (all from Colombia), and *Curvularia* species and *Scedosporium* species (from Italy and Greece, respectively) were also reported.
must keep in mind that these are in flux because of international travel and immigration.

The treatment regimens that have been reported most frequently include oral terbinafine and itraconazole, which have demonstrated efficacy in infections caused by Scopulariopsis brevicaulis and Aspergillus species. Griseofulvin cannot be recommended because of poor efficacy. The small amount of data on ciclopirox nail lacquer show promise for treating infections caused by Scopulariopsis brevicaulis. While ketoconazole and fluconazole appear to have some efficacy, specifically with regard to Scopulariopsis brevicaulis infections, ketoconazole cannot be recommended as a first-line treatment due to the potential for serious hepatic effects. To maximize the probability of successful treatment, practitioners will often combine these modalities with chemical and/or surgical nail debridement/avulsion.

There are new systemic and topical antifungal agents under evaluation, as well, devices being assessed for the treatment of onychomycosis include lasers, iontophoresis, and photodynamic therapy. It remains to be seen what role these new treatment modalities will play in the management of NDM onychomycosis.

To expand our knowledge of NDMs and their management, we recommend that future studies use (and clearly indicate) at least 3 of the main criteria for diagnosis, and report the clinical type of onychomycosis and the isolated organism. When evaluating different treatments, we suggest that authors clearly define their efficacy outcomes, preferably to include negative mycology (KOH and culture) and complete clinical cure (a completely clear nail).

REFERENCES