BACKGROUND
A 9-year-old healthy boy has had “funny-looking toenails” for more than 4 months (Figure 1). He has no history of foot trauma, psoriasis, or eczema of the foot. His family has unsuccessfully used over-the-counter topical antifungal cream on the nails. Multiple toenails are affected and show onycholysis (separation of the nail plate from the nail bed), yellow discoloration, and thickening of the distal-lateral aspects of the nail. The matrix has been spared.

His mother reports there is a strong family history of “foot fungus.” In fact, his father has had toenail fungus for several decades.

A line was drawn on the patient’s toes to mark the affected area (Figure 2); a photograph was taken of the affected areas. If the patient chooses to retain the marking, it may help him to monitor the improvement in the condition of his nails—the changes will occur slowly.

DIAGNOSIS

The patient’s affected nails were clipped and saved. Subungual debris was obtained by using a small curette. A potassium hydroxide (KOH) preparation failed to reveal any hyphal elements, but there was some fluorescent green staining when calcofluor was used. Fortunately, a periodic acid-Schiff stain (PAS) of the nail clippings was performed by a local pathology laboratory and showed hyphae and arthroconidia. Two weeks later, a dermatophyte test medium (DTM) culture was performed, which turned red and, at week 4, Trichophyton rubrum was identified in the laboratory culture specimen (Figure 3).

This patient has mild distal-lateral subungual onychomycosis, which spared the nail matrix. The etiologic organism was T. rubrum, the most common pathogen in onychomycosis.

TREATMENT

The risks and benefits of various treatment options were discussed with the patient’s parents. They chose ciclopirox nail lacquer, which was prescribed for daily application for 3 months.

FOLLOW-UP AT 3 MONTHS

The patient’s nail showed significant improvement in clinical appearance (Figure 4). No new involvement of the infection was noted. The patient continued...
treatment for an additional 4 months. After 7 months of treatment, the patient’s nails were completely clear (Figure 5).

**DISCUSSION**

Onychomycosis is considered an uncommon disease in children, but its prevalence is increasing. The prevalence in North American children is 0.44% and is 0.3% worldwide. The disease is more common in adolescence than in early childhood, but it can occur at any age. The youngest reported case was in a 10-week-old infant.

The most common causes of nail dystrophy in children are trauma, fungal infection (onychomycosis), and congenital dystrophies. Severe persistent dystrophy is more common in children with Down’s syndrome, children whose test results are positive for human immunodeficiency virus, and children with mucocutaneous candidiasis. Mucocutaneous candidiasis often manifests with dystrophy of the fingernails and toenails. Affected patients also may have oral findings and underlying endocrine disorders, and often they are infected with *Candida* rather than with the dermatophyte species.

The organisms most often responsible for pediatric fungal nail disease are *T. rubrum, Trichophyton mentagrophytes, Candida albicans, Trichophyton violaceum*, and *Trichophyton soudanense*. Other causes of nail dystrophy include trauma, alopecia areata (patchy hair loss in defined areas), psoriasis, lichen planus (an inflammatory, pruritic, cutaneous disease), foot eczema, and genetic disorders, such as pachonychia congenita.

Onychomycosis is diagnosed by collecting nail clippings and subungual debris and then using any of the following 4 methods: a KOH preparation (Figure 6), fluorescent staining with calcofluor, culturing for fungus, or PAS. Lawry et al showed that PAS appears to be the most sensitive method for diagnosis, especially when combined with a culture (Figure 7). However, not all centers may have this option. Based on cost and ease, physicians initially may use KOH or culture methods.

Several treatment options for onychomycosis are currently available. In children, 2 relevant issues that impact therapeutic choice are off-label drug usage and topical therapy versus systemic therapy. The pediatric nail grows faster than does an adult nail, and the nail plate is thinner in children than in adults, which may be because of blood circulation in the younger population. Because of these characteristics, children may be more likely to respond to topical treatment. Children also are less likely to have dystrophic infection and are more likely to have sparing of the nail matrix; therefore, treatment success rates are likely to be higher with topical therapy. There is less experience with the use of systemic therapy and topical therapy in...
children than in adults, and families are often concerned about the possible adverse effects of oral medication (ie, neutropenia and liver abnormalities). The risk-versus-benefit ratio of any treatment always should be discussed with pediatric patients and their families.

If the disease is mild and the nail matrix is not involved, topical therapy may be an appropriate first therapy for childhood fungal disease of the nails. There are 2 lacquers available that can be painted onto the toes: ciclopirox and amorolfine. Both lacquers are efficacious in appropriate patients, but ciclopirox is the only product easily available in the United States. Other options for more severe cases include a bifonazole (1%)-urea (40%) cream applied to the toenail for 15 days, followed by removal of the nail and use of a bifonazole cream for an additional 4 weeks. Bonifaz and Ibarra showed that this treatment yielded a 68% cure rate, and a further 24% improvement was shown in a study involving 25 children. Unfortunately, bifonazole is not easily procured in the United States, but other topical antifungal creams could be substituted. Various formulations of urea are available and are useful in some patients. All of these treatments are currently off-label for use in children.

**CLINICIAN INTERVIEW**

Dr Friedlander is a pediatric dermatologist with subspecialty training in infectious diseases and is a clinical professor of pediatrics and medicine at the University of California, San Diego School of Medicine, and the affiliated Children’s Hospital and Health Center. She treats children with congenital and acquired skin conditions and is particularly interested in cutaneous infections and pediatric vascular lesions.

*Advanced Studies in Medicine (ASiM)* interviewed Dr Friedlander about this case study involving a child with onychomycosis, asking her to provide more insight into the practical clinical aspects of diagnosing and treating onychomycosis in primary care and the special considerations in pediatric patients.

**ASiM:** How does a culture affect treatment choice, especially if results may not be available for up to 1 month?

**Dr Friedlander:** A culture is extremely important because sometimes nails appear as though a fungus is present but, in fact, the nail changes have been caused by something else, possibly psoriasis or trauma or even a less common disorder (eg, lichen planus). Most dermatologists strongly think that infection should be documented to avoid the cost of utilizing drugs that will be ineffective and to avoid unnecessary adverse reactions. If patients do not respond to treatment and if there is no culture documentation, clinicians will
not know if they are on the right track. Fungal culture results are not necessary before starting treatment with ciclopirox nail lacquer because there are few toxicities associated with ciclopirox. If the patient is not improving 1 month after ciclopirox therapy is initiated, there is no organism growth in the culture, and/or the results of the PAS are negative, then the patient has not been exposed unnecessarily to the potential systemic adverse effects. However, before systemic therapy is begun, I would prefer documentation that there is, in fact, a dermatophyte infection.

Determining the specific organism is not as critical. Sometimes patients’ nails will have a mold that may not respond to the usual therapies, but most patients will have *T. rubrum*. It is beneficial to know the specific organism but, more importantly, to determine that it is a nail fungus rather than psoriasis or nail-related trauma. DTM is an easy method to assess dermatophyte infections. I discussed 2 types of cultures in this case study. DTM, in which the medium turns red, is difficult for determining the type of dermatophyte but easy to establish that there is a dermatophyte. With Mycosel [agar], the medium doesn’t turn red but the organism type can be determined by colony morphology. Many practitioners use only the DTM culture because they are not trained to read colonies, and a simple “is it red?” system works better for them. Other practitioners may prefer to send the culture to a laboratory.

**ASiM:** What is the PAS stain? How does it work?

**Dr Friedlander:** PAS affects fungal elements. If nail clippings are sent to the laboratory and if the clippings contain hyphae, the PAS will cause those fungal elements to turn red.

**ASiM:** You included several steps to make a diagnosis—KOH and PAS. Are they specific for diagnosing dermatophytes? What other methods were you considering during the diagnosis process?

**Dr Friedlander:** The PAS and KOH are useful and are sufficient for diagnosis. In approximately 5% of the cases using PAS stain, a mold rather than a true dermatophyte is found. Sometimes the molds and dermatophytes are coexisting, and it would not be inappropriate in this case to treat the patient. If the patient did not respond to treatment, the clinician may perform a second culture. I also talked about the study by Lawry et al, which showed that PAS and a culture together provide a more sensitive diagnosis than a culture alone or PAS alone, but PAS often is not as easily obtainable as is a culture. Most practitioners would begin with a culture; however, if they are highly suspicious that dermatophytes are present but the culture is negative and the culture results are negative, then they also could send the PAS to the laboratory.

**ASiM:** Why was it important that the nail matrix was spared? What would have happened if the matrix had been involved? How would your treatment have changed?

**Dr Friedlander:** We know that in adults—and I strongly think also in children—if the nail matrix is involved, patients are much less likely to respond to topical ciclopirox. Generally, if the matrix is involved, systemic therapy probably is required. Therefore, I would prefer that ciclopirox is prescribed for patients who do not have nail matrix involvement. Could it work when the matrix is involved? Maybe, but it’s less likely. Treatment is more likely to be effective in patients without a severe disease.

**ASiM:** In the case study, you mentioned that the patient’s father had “foot fungus.” Do you address the “foot fungus” in the other family members, thus it doesn’t spread? If so, what do you recommend?

**Dr Friedlander:** It’s always a good idea to speak with the family and to investigate if other family members are affected with the same condition. We have performed a small study that evaluates and treats children with toenail infections. Study results show that 100% of the affected children had at least 1 family member who had nail infections. This finding supports our position that genetic predisposition may play an important role in this disease. However, some researchers may say this supports the importance of cross-infection among people sharing the same bathing facilities and towels. Either way, if other family members are affected, they also should receive treatment. Many clinicians prescribe powders or topical creams as a prophylaxis; some prescribe topical ciclopirox once the patient is cured. However, the standard of care is unclear. There are precautions the family can take, such as keeping the feet dry, using flip-flops at public swimming pools, and decreasing the amount of time occluded sweaty shoes are worn.
REFERENCES