

Fungal Skin Infections

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Education Gap

Most pediatricians appear to be familiar with candidal diaper dermatitis, but there is a lack of knowledge about other, less common fungal infections in children.

Objectives After completing this article, readers should be able to:

1. Recognize the clinical presentations of different fungal infections in children.
2. Know the differential diagnosis of various fungal skin infections.
3. Know what diagnostic tests can be used to confirm infection.
4. Be aware of available treatment options and how to manage the infections appropriately.

INTRODUCTION

Candidal diaper dermatitis is the most common fungal infection of childhood. This yeast infection almost always secondarily invades diaper-area skin that has been damaged by an irritant contact dermatitis from maceration, urine, and/or stool. Children in the preschool-age group who no longer wear diapers are more likely to develop tinea infections, particularly tinea capitis. Tinea refers to dermatophyte infections in the epidermis and areas high in keratin, such as the hair and nails. In prepubertal children, tinea capitis and tinea corporis are most common; in adolescence, tinea pedis (TP), tinea cruris, and tinea unguium (onychomycosis) are more common. (1) Yeast infections other than candidal diaper dermatitis, including pityriasis versicolor (PV) (formerly known as tinea versicolor) and mucocutaneous candidiasis (MC), may also occur. Chronic MC (CMC) is a rare, usually inherited disorder. PV is a common infection in adolescents and adults that usually affects the sebum-prone areas (face, chest, back). Fungal infections can be a substantial source of morbidity in the pediatric population, accounting for about 15% of pediatric outpatient visits in the United States. (2)

This article reviews the epidemiology and clinical presentations of tinea infections (capitis, corporis, pedis, cruris, unguium), PV, and MC in children. The

AUTHOR DISCLOSURE Dr A. Gupta has disclosed that he is on the Speakers' Bureaus of Valeant, Janssen, Novartis, and Bayer; he is a consultant for Anacor, Sandoz, and Moberg Pharma; and he is a clinical trials investigator for Valeant Canada, Nuvolase, Bristol Meyers Squibb, Eli Lilly, Merck, Novartis, Janssen, and Allergan. Ms MacLeod and Dr Foley have disclosed that they are employees of Mediprobe Research, Inc, which conducts clinical trials under the supervision of Dr. A. Gupta. Drs G. Gupta and Fallon Friedlander have disclosed no financial relationships relevant to this article. This commentary does contain a discussion of an unapproved/investigative use of a commercial product/device.

ABBREVIATIONS

CMC	Chronic mucocutaneous candidiasis
HIV	Human immunodeficiency virus
id	Dermatophytid
KOH	Potassium hydroxide
MC	Mucocutaneous candidiasis
PCR	Polymerase chain reaction
PV	Pityriasis versicolor
TP	Tinea pedis

differential diagnosis and methods for confirming diagnosis based on clinical presentation are discussed. Recommended treatment options for each type of infection are specified (Table 1). Of note, many recommendations are off-label, as the safety of many agents has not been established for children.

TINEA CAPITIS

Epidemiology

Tinea capitis, a communicable fungal infection of the scalp and hair shaft, is the most common fungal infection in children. (3) The prevalence ranges from less than 1% in western Europe to as much as 50% in Ethiopia where the infection is endemic. (4) In North America, the prevalence is estimated to range from 3% to 8% in children. It is unclear whether it is increasing, but immigrant populations, particularly those from Africa, are at higher risk. (5) Tinea capitis most often affects children between ages 3 and 9 years, those of African heritage, those of low socioeconomic status, and those residing in urban settings and/or crowded living conditions. (1)(4) Prior to the 1950s, *Microsporum*

audouinii was the major source of tinea capitis in North America. (6) Subsequently, epidemiology shifted and currently about 95% of tinea capitis in North America is caused by *Trichophyton* species (predominantly *T tonsurans*). *Microsporum* species, (7) usually transmitted by pets, causes the remainder of the cases. However, in central and southern Europe as well as in developing countries, *M canis* is the most common causal species. (7) It is important for clinicians to be aware of the predominant pathogen in their communities because this has implications for optimal treatment choice.

Clinical Presentation

Tinea capitis may be difficult to diagnose because clinical signs may be subtle and can vary substantially from child to child. Symptoms may include scaling, alopecia, broken hair shafts at the scalp, erythema, pustules, and/or large boggy scalp masses. Patients may complain of pruritus or tenderness, and occipital and posterior cervical adenopathy are often present (Fig 1). A nonspecific, eczematous, pruritic eruption may be noted on the trunk and extremities either before or

TABLE 1. **Summary of Treatment Recommendations for Tinea Infections in Children***

INFECTION	FIRST-LINE TREATMENT	ALTERNATIVES	TERTIARY OPTIONS
Tinea capitis	Oral antifungals: terbinafine, griseofulvin (<i>Microsporum canis</i>)	Adjunctive agents: selenium sulfide shampoo, ketoconazole shampoo	Itraconazole, fluconazole
Tinea corporis/ Tinea cruris	Topical antifungals: butenafine, ciclopirox, clotrimazole, miconazole, terbinafine, tolnaftate	Oral antifungals (resistant or severe infection): terbinafine, griseofulvin, itraconazole, fluconazole	
Tinea pedis	Topical antifungals: butenafine, clotrimazole, miconazole, terbinafine	Topical antifungals: ciclopirox Oral antifungals (resistant or recurrent infection): terbinafine, itraconazole, fluconazole	Urea cream
Pityriasis versicolor	Zinc pyrithione, selenium sulfide, or ketoconazole shampoos Other topical antifungals: clotrimazole, ketoconazole, miconazole, terbinafine	Oral antifungals (resistant, recurring, serious infection): itraconazole, fluconazole	
Tinea unguium (onychomycosis)	Topical antifungals: ciclopirox, efinaconazole, tavaborole	Oral antifungals (severe infection): terbinafine	Itraconazole, fluconazole
MC – Oropharyngeal candidiasis	Mild: Clotrimazole troches, miconazole, nystatin suspension Moderate-severe: fluconazole	Fluconazole-resistant infections: itraconazole, posaconazole suspension	Amphotericin B
MC – Esophageal candidiasis/CMC	Fluconazole	Intravenous fluconazole, echinocandin (anidulafungin, caspofungin, micafungin) Fluconazole-resistant infections: itraconazole, voriconazole, amphotericin B, or an echinocandin	Amphotericin B

*Some agents may be used off-label usage in children or be approved for particular ages. See Table 3 for details.
CMC=chronic mucocutaneous candidiasis, MC=mucocutaneous candidiasis.

during treatment; this is known as an autoeczematization or dermatophytid (id) eruption. Tinea capitis typically presents as 1 of 6 clinical patterns: gray type, black dot, diffuse scale, pustular type, favus, and kerion. Gray type is characterized by circular patches of alopecia and marked scaling with or without erythema. (4)(8) Black dot presents with patches of alopecia and is dotted with broken hair stubs (“black dots”). Diffuse scale is characterized by widespread scaling and is dandruff-like, with or without erythema. Pustular type presents as alopecia with scattered pustules, scaling, and lymphadenopathy. Favus has distinctive yellow cup-shaped crusting around the hair called scutula, along with patchy alopecia and generalized scale; this variant is extremely rare and not usually seen in the United States. Kerion is a boggy tumor with pustules, lymphadenopathy, erythema, and tenderness. (4)(8) It is the most severe inflammatory response and can be caused by either *T tonsurans* or *M canis*. (9) When children present without distinguishing characteristics of tinea capitis such as black dot alopecia or kerion, diagnosis may be simplified by recognizing clusters of symptoms. Hubbard (10) found that children with adenopathy, alopecia, pruritus, and scaling were most likely to have a positive culture. Some dermatologists now use scalp dermoscopy (visualization of scalp and hair shaft with magnification and light) to increase diagnostic accuracy; corkscrew and comma-shaped hairs are frequently seen in fungal scalp infections. (11)

Differential Diagnosis

Because of its broad and varying symptoms, tinea capitis has a substantial differential diagnosis. Among the possibilities are alopecia areata, atopic dermatitis, bacterial scalp abscess, seborrheic dermatitis, trichotillomania, traction alopecia, psoriasis, lichen planopilaris, lupus erythematosus, syphilis, and Langerhans cell histiocytosis (Table 2). (1)(3)(6)



Figure 1. Tinea capitis. Photo courtesy of Dr Avner Shemer, The Chaim Sheba Medical Center Israel.

Diagnostic Tests

Clinical diagnosis should be confirmed via either potassium hydroxide (KOH) microscopy or culture. Culture is preferable because speciation is provided, allowing determination of the most appropriate treatment option. Polymerase chain reaction (PCR) evaluation of dermatophyte infections has become much more cost effective and “kits” are now available, which is likely to lead to wider availability of this exceedingly rapid and sensitive test in the next few years. At this time, PCR appears more sensitive for nail and skin infections than for hair samples. (12) Wood’s light examination causes *Microsporum* species to fluoresce, but most infections in North America are caused by *T tonsurans*, which does not fluoresce. (13) Pathogens that do fluoresce include *Microsporum* species and *Trichophyton schoenleinii*. (7) Under microscopic analysis, an infected hair can present with mycelium (mass of fungal hyphae) on the external surface of the hair shaft (ectothrix) or with mycelium within the hair shaft (endothrix). (7) A favus infection presents with fungal hyphae and characteristic airspaces within the hair shaft. (7) Wood’s light analysis takes minutes to complete compared with 1 to 4 weeks required for culture results, which are accompanied by low culture-positive rates, all of which may delay treatment and increase the spread of infection. (10)

A reasonable course is to start treating children with typical presentations before culture confirmation, although a culture should be attempted. Samples may be obtained either from plucked hairs or cotton swabs that have been premoistened and rolled over the affected site and are inoculated into transport culture. (14)

Kerion (abscesses filled with purulent exudate) should be treated aggressively with systemic antifungal medication pending laboratory results because if left untreated, permanent hair loss and scarring may occur. Unfortunately, the degree of inflammation noted in a kerion is not linked to the fungal burden, and cultures may sometimes be negative. However, every attempt should be made to swab the kerion area as well as other areas of the scalp with a cotton swab.

Tinea capitis infection may spread from the scalp to other areas of the body (eg, causing tinea corporis) and secondary bacterial infections (eg, *Staphylococcus aureus*) may occur. (15) If children are unlikely to have an infection (eg, no adenopathy and scaling), experts recommend confirming infection via KOH microscopy or a culture before treatment. (4)

Treatment

Systemic treatment is required to penetrate hair shafts. Traditionally, griseofulvin was considered the treatment of choice, (16) but a Cochrane collaborative analysis found that terbinafine, fluconazole, and itraconazole are as effective as

TABLE 2. **Differential Diagnosis of Tinea Capitis (1)(2)(6)**

DISORDER	DISTINGUISHING CHARACTERISTICS OF CLINICAL PRESENTATION
Alopecia areata	Patches of hair loss; total loss of hair; fine miniature hair growth; exclamation point hairs; can involve eyebrows, eyelashes, beards; possible nail pitting Uncommon: scaling, crusting, inflammation (consider infection, other diagnoses)
Atopic dermatitis	Personal or family history of atopy, may appear on face Uncommon: alopecia, large posterior occipital or cervical nodes, erythema of scalp usually minimal with diffuse faint scales common
Bacterial scalp abscess	Culture should be used to distinguish from kerion
Seborrheic dermatitis	Greasy scaling, typical distribution includes nasolabial folds, hairline, eyebrows, postauricular folds, chest Uncommon: alopecia and significant lymphadenopathy
Trichotillomania	Often involves eyelashes and eyebrows, hairs of varying lengths, scaling uncommon, large geometric shapes of alopecia present
Traction alopecia	Hair loss in areas under tension; folliculitis may also be present
Psoriasis	Gray or silver scaling that extends beyond scalp line, nail pitting, family history, involvement of other sites
Lichen planopilaris	Often affects skin, mucosa, and nails; no hair follicles seen in areas of hair loss; slowly progressive
Lupus erythematosus	Involves skin, especially face and sometimes connective tissue of internal organs; discoid lesions can lead to scarring
Syphilis	Involves other areas of the body, not pruritic, scaling uncommon
Langerhans cell histiocytosis	May involve buttocks, liver problems causing jaundice, fluid in the belly, bulging eyes or eye problems

griseofulvin, with shorter periods of treatment with newer antifungals achieving similar results to griseofulvin. (17) For *Trichophyton* species, terbinafine is preferable, but this agent is not as effective as griseofulvin for *Microsporum* species. (17)(18) When a child presents with a lesion highly suspicious for *Microsporum* species (eg, infected cat or dog at home, and/or lesion fluoresces under Wood's lamp), griseofulvin should be used. Most experts believe that effective treatment doses of griseofulvin should be higher than advised in the package insert (Table 3). If griseofulvin is not available or terbinafine is preferred, the duration of treatment for *Microsporum* species may be longer compared to the duration for *Trichophyton* species. The duration of treatment for terbinafine is generally 4 to 6 weeks, and continuing treatment for 2 weeks after symptoms resolve may be beneficial. (8) Griseofulvin therapy is generally used for 8 weeks, but many experts reevaluate a child after 4 to 6 weeks of therapy to consider discontinuation. Some systemic antifungals, such as itraconazole and fluconazole, have been successfully used for pediatric tinea capitis, but such use is off-label, and a large multinational study investigating fluconazole reported cure rates below those seen with either griseofulvin or terbinafine. (40) Nonetheless, fluconazole has been widely used in children for candidiasis and may be an option when other agents are either not available or not covered by the patient's insurance plan (Table 3).

Adjunctive therapy with either selenium sulfide shampoo (1% or 2.5%) (41) or ketoconazole shampoo should be used to decrease the spread of infection. (1)(42) Because tinea capitis is communicable, children should not attend school or child care until treatment has started. Once treatment has begun, the child may return to school but should not share combs, brushes, helmets, or other items that come in contact with the scalp or play contact sports for 14 days to avoid transmission. (1) Household members should be queried and clinically examined for signs and symptoms if possible and mycologically tested if these exist. The use of selenium sulfide shampoo or ketoconazole shampoo prophylactically (2 times/wk for 2-4 weeks) is controversial, and no clear evidence-based data support its use for this purpose, although some experts recommend this. Some also recommend the same prophylaxis for people outside the home in close contact with the child. (1)(4) Close contacts include other children seen daily, such as in a classroom or child care. Although this process may seem daunting, families at least should be informed so that children can be monitored for signs and symptoms and given the option to engage in prophylactic treatment.

In some cases, patients may develop an immune response to the fungus triggered by treatment, known as an id reaction. It often presents as a pruritic, papular, or vesicular rash on the face and body and may be alleviated by

TABLE 3. Antifungal Agents for Fungal Infections in Children

ANTIFUNGAL	DOSAGE	DURATION	APPLICABLE INFECTIONS	NOTES	MONITORING GUIDELINES	OTC OR PRESCRIPTION
Topical:						
Butenafine hydrochloride	1% cream, twice daily (19)	1 week	Tinea corporis, tinea pedis, tinea cruris	Children 12+ years		OTC
Ciclopirox	0.77% cream, twice daily (20)	1 week	Tinea corporis, tinea pedis, tinea cruris	Safety in children <10 years has not been established When topical clotrimazole and miconazole fail		OTC
	8% lacquer, daily with weekly professional debridement	48 weeks	Onychomycosis	Considered safe for 12+ years		Prescription
Clotrimazole	1% cream, twice daily (21)	4 weeks	Tinea corporis, tinea pedis	Children 2+ years		OTC
	1% cream, twice daily (21)	2 weeks	Tinea cruris	Children 2+ years		OTC
	1% cream, twice daily (22)	1-2 weeks	Pityriasis versicolor	Children 2+ years		OTC
Efinaconazole	10% solution, daily	48 weeks	Onychomycosis	Safety and efficacy not established		Prescription
Ketoconazole shampoo	2% once (23)	Once	Tinea capitis	To decrease spread of infection as an adjunct therapy Safety in children not established		OTC
	2% daily (22)	3-14 days, up to 4 weeks	Pityriasis versicolor	See above for safety Following treatment, use monthly for 3 months to prevent recurrence		OTC
Miconazole	2% cream, twice daily (24)	4 weeks	Tinea corporis, tinea pedis	Children 2+ years		OTC
	2% cream, twice daily (24)	2 weeks	Tinea cruris	Children 2+ years		OTC
	2% cream, once or twice daily (22)	2 weeks	Pityriasis versicolor	Children 2+ years		OTC
Selenium sulphide shampoo	1% or 2.5% 2 times a week (25)	Duration of oral treatment	Tinea capitis	To decrease spread of infection as an adjunct therapy Safety in children <12 years has not been established for 2.5%		OTC for 1% Prescription for 2.5%
	1% (shampoo) or 2.5% (lotion) daily (22)	1-2 weeks, up to 4 weeks	Pityriasis versicolor	See above for safety Following treatment, use monthly for 3 months to prevent recurrence		OTC
Tavaborole	5% solution daily	48 weeks	Onychomycosis	Safety and efficacy not established		Prescription
Terbinafine	1% cream twice daily (26)	1-2 weeks	Tinea corporis, tinea pedis, tinea cruris	Children 12+ years		OTC
	1% cream once or twice daily (22)	1-2 weeks	Pityriasis versicolor	When topical clotrimazole and miconazole fail Children 12+ years		OTC

Continued

TABLE 3. (Continued)

ANTIFUNGAL	DOSAGE	DURATION	APPLICABLE INFECTIONS	NOTES	MONITORING GUIDELINES	OTC OR PRESCRIPTION
Tolnaftate	1% cream twice daily (27)	4 weeks	Tinea corporis, tinea pedis, tinea cruris	Children 2+ years		OTC
Urea cream	39% twice daily (28)	Not available	Tinea pedis	Safety in children not established When topical terbinafine and ciclopirox fail		OTC
Oral:						
Clotrimazole troches	10 mg 5 times a day (29)	2 weeks	MC	Children 3+ years (need to swallow them properly)		Prescription
Fluconazole (tablet)	3-6 mg/kg daily (30)	2-3 weeks,	Tinea capitis,	For mild-to-severe MC	Liver tests,	Prescription
	12 mg/kg daily for neonates (31)	additional 2 weeks after symptoms resolve	tinea corporis, tinea pedis, tinea cruris, MC	Extensive or resistant tinea infections when not tinea capitis	exercise caution if liver dysfunction	
	Loading dose first day	FN: 12 weeks	Onychomycosis	Not approved for onychomycosis	See above	Prescription
	3-6 mg/kg weekly (32)	TN: 26 weeks				
Griseofulvin* (microsize)	10 mg/kg daily (33) up to 20-25 mg/kg daily	6-8 weeks tinea capitis, 4-8 weeks tinea pedis	Tinea capitis, tinea corporis, tinea pedis, tinea cruris	Children 2+ years Extensive or resistant tinea infections when not tinea capitis		Prescription
Itraconazole (capsules)	5 mg/kg daily (1)(31)	4-6 weeks	MC, tinea capitis, tinea corporis, tinea pedis, tinea cruris, onychomycosis	Safety not established in children For fluconazole-resistant MC Extensive or resistant tinea infections when not tinea capitis	Liver tests, exercise caution if liver dysfunction	Prescription
	Pulse (1 week on therapy, 3 weeks off)	FN: 2 pulses TN: 3 pulses		Efficacy and safety not established in children	See above, do not use if congestive heart failure	Prescription
	10-20 kg: 50 mg every other day, 3x/week; 20-30 kg: 100 mg/day; 30-40 kg: 100 mg/day alternating 200 mg/day; 40-50 kg: 200 mg/day; >50 kg: 200 mg 2x/day (32)					
Nystatin suspension	100,000 U/mL, 4-6 mL, 4 times a day for older children, 2 mL for younger children (34)	48 hours after symptoms resolved	MC			Prescription
Terbinafine (oral granules)	125 mg/day for <25 kg	6 weeks	Tinea capitis, tinea corporis, tinea pedis, tinea cruris	Children 4+ years	ALT, AST, do not use if liver dysfunction	Prescription
	187.5 mg/day for 25-35 kg 250 mg/day for >35 kg (35)			Extensive or resistant tinea infections when not tinea capitis		

Continued

TABLE 3. (Continued)

ANTIFUNGAL	DOSAGE	DURATION	APPLICABLE INFECTIONS	NOTES	MONITORING GUIDELINES	OTC OR PRESCRIPTION
Terbinafine (tablets)	Same dosage as above	FN: 6 weeks TN: 12 weeks	Onychomycosis	Efficacy and safety not assessed in children	See above	Prescription
Amphotericin B	0.25-1.5 mg/kg daily (36)	Based on severity	MC	Safety in children not established When clotrimazole, nystatin, fluconazole, itraconazole fail	Renal, liver, hematologic tests, monitor electrolytes	Prescription
Anidulafungin	0.75-1.5 mg/kg daily (37)(38)	2 weeks after last positive culture	MC	Safety not established in children <16 years When clotrimazole, nystatin, fluconazole, itraconazole fail		Prescription
Caspofungin	Loading dose of 70 mg/m ² , followed by 50 mg/m ² daily	About 2 weeks, may be more	MC	Safety not established in children <12 months When clotrimazole, nystatin, fluconazole, itraconazole fail		Prescription
Micafungin	2-3 mg/kg daily for children ≤ 30 kg 2-2.25 mg/kg daily for children >30 kg (39)	About 2 weeks, may be more or less	MC	Safety not established in children <4 months When clotrimazole, nystatin, fluconazole, itraconazole fail		Prescription

ALT=alanine aminotransferase, AST=aspartate aminotransferase, FN=fingernails, MC=mucocutaneous candidiasis, OTC=over-the-counter, TN=toenails.

*Griseofulvin is no longer available in Canada. Other than griseofulvin, all of the drugs listed have been approved and are available for use in the United States and Canada, but they are not all indicated for use in children, as specified in the Notes column of the table.

This review is limited to the United States and Canada. Information is based on package inserts obtained from the National Institutes of Health, United States National Library of Medicine, DailyMed; United States Food and Drug Administration Approved Drug Products Database; and Health Canada's Drug Product Database.

Please check the regulatory status of each drug in your jurisdiction. Check for current dosing and monitoring guidelines. Table 3 is presented as a guide only.

topical corticosteroids and systemic antihistamines. However, an id reaction does not necessarily require discontinuing treatment and may occur before institution of therapy. (13)(43) This reaction should be distinguished from a drug reaction, but id reactions are much more common. (5)

TINEA CORPORIS

Epidemiology

Tinea corporis is a dermatophyte infection of the body, often referred to as ringworm. It can be caused by any dermatophyte that infects humans. Among young children, acute infections may be caused by *M canis* from contact with dog or cat carriers. (2) However, in North America, it is most commonly caused by *Trichophyton* species, especially *T tonsurans* and *Trichophyton rubrum*. (2)(3)(4) Tinea corporis may be spread by close body contact and has been found to be more prevalent in warm and moist environments and

among wrestlers (*tinea corporis gladiatorum*), where it is often limited to the neck and arms but may also involve the scalp. (2)

Clinical Presentation

Tinea corporis presents as a single or multiple red, scaly papules (sometimes follicular) that may spread and combine, forming plaques that tend to be annular and clear in the center. (2) The plaques generally are limited to a few sites on the body and are usually unilateral (Fig 2). (2) Mild erythema, edema, vesicles, pustules, or bulla formation can occur, and the sites may be pruritic. (2) The presence of pustules and inflammation tends to be more common with infections caused by *M canis* whereas follicular infections are often caused by *T rubrum*. (2) In addition, follicular inflammatory reactions are more common among patients who have used topical corticosteroids. (2) Because the use of topical corticosteroids (eg, when atopic dermatitis is

suspected) may alter the appearance of tinea corporis (tinea incognita), physicians should use clinical judgement in obtaining a sample for KOH microscopy for annular scaly skin lesions, particularly for those lesions that have an atypical appearance. (4)

Differential Diagnosis

The differential diagnosis of tinea corporis includes granuloma annulare, nummular eczema, erythema multiforme, erythema annulare centrifugum, psoriasis, pityriasis rosea, subacute cutaneous or discoid lupus, atopic dermatitis, candidiasis, fixed drug eruption, early Lyme disease, and seborrheic dermatitis. (1)(2) These conditions often have several characteristics that distinguish them from tinea corporis. For example, granuloma annulare is smooth; has no scaling, vesicles, pustules, or pruritus; and is often nodular (dermal with no epidermal component) and present on the dorsum of the hands or feet. (1) Histologically the epidermis is not affected; rather, inflammation is in the dermis. (4) Nummular eczema is less likely to have central clearing and has more convergent scaling while erythema multiforme is characterized by acute-onset target lesions (sometimes oral) without scaling. (1) For additional differentiating characteristics, please refer to Ely et al (1) and Kelly. (4)



Figure 2. Tinea corporis. Photo courtesy of Dr Avner Shemer, The Chaim Sheba Medical Center Israel.

Diagnostic Tests

Diagnosis can be confirmed with KOH microscopy or a culture, although cultures are usually not needed.

Treatment

Topical antifungals are generally effective and should be used for 1 additional week after symptoms resolve. (2) Some have suggested that butenafine and terbinafine are more effective than miconazole and clotrimazole. (3) Topical corticosteroids eventually worsen the infection and should not be used. When topical treatments fail or infections recur, oral antifungals may be needed. This is often the case for those who have had prolonged pretreatment with topical corticosteroids, those who have follicular infections, and for individuals who are immunocompromised because they often have extensive and severe infections. Because tinea corporis is more common in warm and humid environments, the skin should be kept cool and dry to promote healing. (2)(4)

TINEA PEDIS

Epidemiology

TP, known as athlete's foot, is largely caused by *T rubrum* and *Trichophyton mentagrophytes*. Athlete's foot is most common among adolescents and is relatively rare among prepubertal children. Prevalence is estimated to be approximately 3% to 9% in children. (44)(45)(46)(47)(48) Because TP is uncommon among children, it is often misdiagnosed. (49) This can be problematic because treatment with topical corticosteroids may alter the clinical appearance, making subsequent diagnosis difficult. (50)

Clinical Presentation

Symptoms of TP include erythema, scaling, fissures, maceration, and pruritus between the toes extending to the soles, borders, and sometimes the dorsum of the foot (Fig 3). Onychomycosis may occur concomitantly. (1) The 3 typical presentations are intertriginous dermatitis (interdigital), "moccasin" pattern, and vesicular. Interdigital TP is the most common presentation and is characterized by scaling (usually between the fourth and fifth toes (9) because for anatomic reasons this web space tends to be the most occluded), maceration, pruritus, and fissuring of the lateral toe web spaces that may spread to the soles and dorsum of the foot. (51) This presentation often starts in the toe web where maceration and moisture are present. (9) Moccasin TP is typically chronic and is characterized by dry scaling patches or hyperkeratotic plaques, erythema on the soles and border of the foot, and possibly tenderness or pruritus.



Figure 3. Tinea pedis. Photo courtesy of Dr Avner Shemer, The Chaim Sheba Medical Center Israel.

(51) This presentation may also involve infection of the nails (onychomycosis) and hand (tinea manuum). (9) The vesicular presentation is characterized by vesicles and pustules that are often on the anterior sole or instep but can occur on all areas of the foot (51), often accompanied by intertriginous infections. (9)

Differential Diagnosis

TP may appear similar to contact dermatitis, dyshidrotic eczema, foot eczema, juvenile plantar dermatosis, and psoriasis, although TP is generally more likely to affect the intertriginous areas. (3) However, Guentz (51) argues that TP should be included as a differential diagnosis for every child who presents with a foot rash. Contact dermatitis can be distinguished from TP because the distribution generally matches the footwear. (1) Dyshidrotic eczema uniquely presents with vesicles on the lateral aspects of the digits and often involves the hands. Children with foot eczema may have an atopic history. Juvenile plantar dermatosis is characterized by shiny, taut skin involving the great toe, ball of the foot, and heel. Psoriasis usually involves other sites and presents with gray or silver scale, nail pitting or other nail signs, occasionally arthritis, and possibly a family history. (1)

Diagnostic Tests

In cases with a typical presentation, diagnosis based on appearance may be adequate; when the presentation is atypical, KOH microscopy or a culture is recommended. (1) KOH microscopy may be difficult with vesicular presentations because samples should be taken from the root of the vesicle. (9)

Treatment

Topical antifungals such as azoles or allylamines are usually effective in treating TP, with the duration of therapy ranging from 1 to 4 weeks based on the agent (Table 3). First-line treatment is generally topical clotrimazole, miconazole, naftifine, or terbinafine. If such therapy is unsuccessful, the patient should be reevaluated and other topical agents can be used, including ciclopirox (52) and butenafine hydrochloride. (3) Upon failure of other topical treatments, high-potency urea cream is a consideration as adjunctive therapy. This agent functions as both a keratolytic and humectant (to keep moist) and is useful in removing scale. (28)(52) Patients should thoroughly dry their feet before applying topical antifungals. Wearing breathable shoes with 100% cotton socks changed twice daily also is recommended. (51) Adjunctive treatments such as topical antiperspirants (eg, aluminum chloride) may be used if there is extreme sweating. (2) Cool tap water or Burow's solution soaks may help relieve discomfort, particularly if secondary bacterial infection is suspected. (52)

If the infection is extensive or involves the toenails, is recalcitrant or recurrent, or presents in immunosuppressed patients or as moccasin TP, systemic therapy (eg, terbinafine, fluconazole, itraconazole) may be required. (51)(52)(53) In moccasin type TP, topical treatment is typically only useful for reducing the spread of lesions. (9) With extensive maceration, bacterial infection (ie, dermatophytosis complex) also may occur, requiring simultaneous antibiotic therapy. (2)(52) As with tinea capitis, an id reaction may occur with treatment, but the hand is usually the first place to react in TP. (9)

TINEA CRURIS

Epidemiology

Tinea cruris (jock itch) primarily affects adolescent and young adult males; it is less common among children. Risk factors include diabetes, obesity, crowded living conditions, tight or wet clothing in the groin area, membership in a sports team, and a fungal infection on another part of the body. (54) In North America, jock itch is most often caused by *T rubrum*, although *Epidermophyton floccosum* is also a common pathogen. (2) It can be spread by fabric such as clothing, towels, and sheets as well as by direct contact, especially in warm and humid environments. (2) A person who has tinea cruris may also have tinea pedis because they can both be caused by *T rubrum*. (2) Accordingly, the feet should always be examined in a child presenting with tinea cruris. (54)

Clinical Presentation

Tinea cruris occurs on the upper-medial thighs with borders that generally spread outwards, possibly extending to the buttocks and above the waistline. It usually spares the scrotum (in contrast to candidal infections) and is characterized by edema, erythema, skin-colored (hyperpigmented) scaling, papules or plaques that can become vesicles or pustules, and often maceration. (2) Compared to tinea corporis, there is usually less central clearing and inflammation. (2) Tinea cruris is typically very itchy, and scratching of the skin may create lichenification as well as thickening of the scrotal skin. This may falsely create the appearance of an infection involving the scrotum. (2) However, the scrotum may be involved if candidiasis is also present. Clinical presentation can be further complicated if the use of topical medications results in allergic contact dermatitis. (2)

Differential Diagnosis

The differential diagnosis of tinea cruris includes candidal intertrigo, erythrasma, inverse psoriasis, and seborrheic dermatitis. Tinea cruris is generally the only one of these conditions that does not affect the scrotum and penis. (1) Distinguishing features of candidal intertrigo include involvement of the scrotum, satellite lesions, and uniform redness. (1) Erythrasma is typically red-brown and does not have a border. It can be distinguished from tinea cruris under Wood's light as it fluoresces coral-red. (1)(2) Inverse psoriasis is red, clearly distinguished by boundaries, and may involve nail pitting. Seborrheic dermatitis involves greasy scaling in the nasolabial folds, hairline, eyebrows, postauricular folds, and chest; lesions are generally not annular. (1) Tinea cruris may also appear similar to contact dermatitis, lichen simplex chronicus, pityriasis versicolor, Darier disease, Majocchi granuloma, Langerhans cell histiocytosis, and pemphigus vegetans. (54)

Diagnostic Tests

KOH microscopy of skin scrapings from the periphery of the lesion should be used to confirm diagnosis. Hyphae in the middle of healthy superficial stratum corneum (known as the "sandwich sign") as well as a deeper parakeratotic or hyperkeratotic stratum corneum may be visible if biopsy is performed. (54) A culture can also be used to confirm diagnosis. PCR may be the diagnostic option of choice in the future.

Treatment

Treatment with topical antifungals, including clotrimazole, miconazole, tolnaftate, and butenafine, is usually adequate.

They should be applied as directed on the affected area and 2 to 3 cm beyond. (54) Oral itraconazole, terbinafine, or fluconazole may be needed to treat extensive or resistant infection. Griseofulvin is not recommended because it adheres poorly to keratinocytes in the stratum corneum. (54) Combined treatment with corticosteroids and oral ketoconazole is also not recommended. (55) Throughout treatment, the affected area should be kept dry and patients should wear loose-fitting clothing and use a separate towel for the groin area after bathing. (54)

TINEA UNGUIUM (ONYCHOMYCOSIS)

Epidemiology

Tinea unguium, widely referred to as onychomycosis to account for fungal infection due to dermatophytes, non-dermatophyte molds, and/or yeasts, is a therapeutically challenging condition that usually requires systemic therapy. The pooled prevalence of culture-confirmed onychomycosis in childhood has been estimated at 0.14%. (56) Risk factors include concomitant TP, family members with TP and/or onychomycosis, and frequent wearing of occlusive footwear (as in organized sports). The most common causative organisms are the dermatophytes *T rubrum* and *Trichophyton mentagrophytes*. Toenails are more commonly affected, although fingernail onychomycosis caused by yeast may be seen in children younger than age 6 years. (57)

Clinical Presentation

Features of tinea unguium may include thickened and dystrophic nails, discoloration ranging from whitish to brown, onycholysis, and/or destruction of all or part of the nail plate (Fig 4). Distal lateral subungual onychomycosis is the most common subtype in all groups, but superficial white onychomycosis, which is characterized by white lesions, is more common in children. Proximal subungual onychomycosis may indicate immunocompromise. Concomitant TP, 2 or more affected nails on the same foot, or unilateral dystrophy of the first and fifth nails may be predictive. (58) When only 1 digit is involved, the possibility of a subungual exostosis (bony projection) should be considered, and radiologic evaluation should be performed, particularly if the patient does not respond to antifungal therapy.

Differential Diagnosis

A number of conditions have similar presentations to onychomycosis, including nail trauma, paronychia, psoriasis, subungual exostosis, and contact/atopic dermatitis. Waiting a short period may lead to resolution of symptoms (ie, from trauma) because children have thinner nail plates



Figure 4. Onychomycosis. Photo courtesy of Dr Avner Shemer, The Chaim Sheba Medical Center Israel.

and faster growing nails. Onychomycosis must be confirmed with mycologic testing before initiating systemic therapy.

Diagnostic Tests

A positive KOH or periodic acid-Schiff stain and positive fungal culture are required for diagnosis. Topical therapy may be started before diagnosis, but identification of the infecting organism allows for selection of the most appropriate systemic therapy. PCR, if available, may also be used and provides results more quickly than culture.

Treatment

In adults, mild-to-moderate disease ($\leq 50\%$ nail involvement) with no matrix involvement allows for consideration of the use of topical antifungals in lieu of systemic drugs. Until recently, ciclopirox was the only topical antifungal available in North America, prescribed off-label (amorolfine is available in the European Union). One small clinical trial has demonstrated the efficacy of ciclopirox in children. (59) Efinaconazole and tavaborole received US Food and Drug Administration approval in 2014. The safety and efficacy of these topical antifungals have not been established in children. However, in a child with mild-to-moderate onychomycosis, particularly if there is no involvement of the nail matrix, and perhaps even in more severe disease, the topical solutions efinaconazole and tavaborole may be considered (off-label use). Efinaconazole and tavaborole may also be an attractive option for adolescents who are concerned about the appearance of their nails as there is evidence that these new antifungals can penetrate the nail plate in the presence of a coat of nail polish. (60)(61) Pediatric studies using these agents are ongoing. There is not enough information on the

efficacy of lasers in treating onychomycosis to recommend their use.

Similar to adults, systemic antifungal medications are recommended for children with established severe onychomycosis. (62) Terbinafine, itraconazole, and fluconazole are prescribed off-label and are effective (Table 3). (32) Immunocompromised patients should not be started on systemic antifungals until their other health care clinicians are involved in the decision-making because the benefits of their use for onychomycosis may not outweigh the risks (eg, drug-drug interactions, hepatic/renal complications, rare marrow effects). Topical antifungal solutions and topical urea creams may be a safer option for such patients.

Medications have varying degrees of effectiveness in treating onychomycosis, with systemic antifungals more effective at eliminating fungus (mycologic cure) than topical antifungals. Concomitant TP should be treated with topical antifungals. Treating family members for TP and/or onychomycosis and advising patients and families to replace old footwear, keep feet clean and dry, and launder socks in hot water to kill fungal spores can help to prevent recurrent disease.

PITYRIASIS VERSICOLOR

Epidemiology

PV (formerly tinea versicolor) is a superficial fungal infection of the skin caused by overgrowth of *Malassezia* species of yeast in the stratum corneum. *Malassezia globosa* is the most frequent causative organism worldwide, with *Malassezia sympodialis* and *Malassezia furfur* also common. (63) PV is not contagious because *Malassezia* species are part of the normal skin flora. These yeasts are more likely to flourish in hot and humid environments. PV is, therefore, more common in the summer months or in tropical climates. PV is more common in adolescents and young adults than in young children because increased sebum production may facilitate fungus growth. (64)

Clinical Presentation

PV is characterized by hyper- or hypopigmented round or oval macules with fine scale and a flaking appearance. It is often diagnosed based on clinical appearance. Lesions are generally confined to the trunk, neck, and upper arms, all of which are areas with a high density of sebaceous glands. The face, particularly the temples, is also commonly affected in children. Lesions are generally asymptomatic, although some patients experience mild pruritus. (64) Fine scale may be difficult to discern and the “evoked scale sign,” a

stretching or scraping of a lesion, produces a visible fine scale that can aid in diagnosis. (65) Hyper- and hypopigmentation do not necessarily resolve with drug therapy; many months may be required for skin to recover a normal appearance.

Differential Diagnosis

Differential diagnoses include postinflammatory hyper (hypo) pigmentation, pityriasis rosea, pityriasis alba, seborrheic dermatitis, vitiligo, and mycosis fungoides. Only PV and seborrheic dermatitis are fungal infections. However, cultures may be negative in both of these disorders, and culturing requires special agents (eg, olive oil) added to the media to support yeast growth. Seborrheic dermatitis affects the head, neck, chest, and intertriginous folds, and erythematous scaling plaques are often symmetric and favor sebum-rich areas. Pityriasis alba usually affects the face, with mild erythema preceding hypopigmented lesions and limited to no fine scaling. A history of inflammatory rash and a lack of scale characterize postinflammatory pigmentation.

Pityriasis rosea usually lasts 1 to 3 months; often occurs in the spring and fall; and presents with a pinkish, erythematous, scaly herald patch followed by the appearance of multiple other plaques, often on the trunk. (66) This is in contrast to PV, in which lesions have finer scale and are hyper- or hypopigmented. An absence of scale in depigmented macules and accentuation of the depigmentation under Wood's light differentiates vitiligo from PV. (67) Mycosis fungoides, although rare, is the most common primary cutaneous lymphoma in children and presents as numerous scaly patches on the trunk and extremities. These lesions are often hypopigmented, particularly in patients of color, and a biopsy is necessary for diagnosis. (68) Diagnosis is often delayed when pityriasis alba, rosea, or PV is suspected instead.

Diagnostic Tests

PV is confirmed via microscopic examination with a positive KOH. Wood's light examination may be clinically helpful but not necessarily conclusive because not all *Malassezia* species fluoresce bright yellow or gold. Skin scrapings should be taken from the edge of lesions, and the transparent tape method may be used if it is difficult to obtain skin scrapings. Under the microscope, *Malassezia* species appear as "spaghetti and meatballs," a combination of short hyphae and round budding yeast cells. A clinical diagnosis should be microscopically confirmed before systemic treatment, but topical treatment can be instituted empirically.

Treatment

A systematic review concluded that topical treatments are effective and well tolerated, with longer durations of treatment more likely to produce favorable outcomes. (69) Shampoos and lotions are applied once or twice daily for 7 to 14 days. One study using ketoconazole shampoo documented good response with daily application for 3 consecutive days. (70) Zinc pyrithione, selenium sulfide shampoo/lotion, and ketoconazole shampoo are applied to affected areas for 5 to 10 minutes and then washed off in the shower. Selenium sulfide may be more likely to cause dry skin. Monthly applications of ketoconazole, zinc pyrithione, or selenium sulfide shampoo for 3 months may prevent recurrence. Effective topical antifungal agents include clotrimazole, miconazole, ketoconazole, and terbinafine.

Systemic treatment with oral antifungals should only be considered in cases of recalcitrant or recurring disease or if large areas are affected. Itraconazole (off-label) and fluconazole are appropriate, but oral terbinafine is ineffective for PV. In adults, itraconazole 200 mg daily for 5 to 7 days or fluconazole 300 mg weekly for 2 to 4 weeks is administered. Relapse following topical or oral treatment is common (60%-80%), and repeated or maintenance therapy may be necessary. (71) Oral ketoconazole should no longer be prescribed for any dermatomycosis in children or adults due to risk of hepatotoxicity. (72)

MUCOCUTANEOUS CANDIDIASIS

Epidemiology

MC encompasses any infection of the body where mucous membrane meets skin that involves a *Candida* species, often *Candida albicans*. However, candidiasis may also occur in folds of skin (intertrigo) such as the groin and corners of the mouth. Due to pediatrician familiarity with candidal diaper dermatitis, this condition will not be discussed further. Relatively few children present with infections in the mouth (oropharyngeal candidiasis) and throat (esophageal candidiasis), known as thrush. Thrush is most common among babies younger than age 1 month and people with compromised immune systems (73) that allow the naturally present *Candida* species to multiply. An estimated 5% to 7% of babies younger than age 1 month (73) and about 39% of children with human immunodeficiency virus (HIV) develop an infection. (74) Other risk factors include old age, endocrine dysfunction, malnutrition, trauma, prematurity, and use of antibiotics and other medical interventions. (2) Chronic mucocutaneous candidiasis (CMC) is even rarer and may involve a genetic component that is

also associated with T-cell immunodeficiency. (75) Patients with CMC have persistent or recurrent infections that can involve the nails and require long-term therapy. (37)(76)

Clinical Presentation

The most common symptoms of thrush are white patches or plaques on the mucous membranes, redness or soreness in the infected area, difficulty swallowing, and cracking at the corners of the mouth. (73)(77) CMC is often more widespread, occurring in the mucous membranes, skin, and nails (onychomycosis). (76)

Differential Diagnosis

The differential diagnosis of MC depends on the location of infection. If the patient has oral candidiasis, the differential diagnosis includes leukoplakia, oral hairy leukoplakia, lichen planus, bullous pemphigoid, pemphigus vulgaris, erythema multiforme, herpes simplex, and aphthous stomatitis. (78) However, none of these diagnoses is commonly found in early childhood. (2) For cases of CMC or intertrigo, the differential diagnosis includes erythrasma, seborrheic dermatitis, dermatitis enteropathica, syphilis, Gram-negative folliculitis, familial benign chronic pemphigus (Hailey-Hailey disease), and bacterial intertrigo. (78)

Diagnostic Tests

Because *Candida* species naturally occur in the body, mycologic tests are of minimal value; the presence of *Candida* species does not imply that there is an infection. (2) Therefore, diagnosis of MC is primarily based on clinical presentation. However, the presence of *Candida* species may be confirmed through KOH microscopy or a culture. (77) The presence of many pseudohyphae supports the diagnosis of a candidal infection.

Treatment

Therapy for oropharyngeal candidiasis primarily involves azole antifungals, either topically or systemically; systemic antifungal therapy is required for esophageal candidiasis and CMC. (37) The following recommendations are based on the most up-to-date clinical practice guidelines provided by the Infectious Diseases Society of America. (37)

Mild cases of oropharyngeal candidiasis can be treated with clotrimazole troches (small tablet or lozenge), miconazole mucoadhesive buccal tablet, or nystatin suspension. (37) Moderate-to-severe cases should be treated with oral fluconazole. (37) In neonates, if creatinine levels are greater

than 1.2 mg/dL (106 μ mol/L) for more than 3 consecutive doses, the dose interval may be decreased to once every 48 hours until the serum creatinine measures less than 1.2 mg/dL (106 μ mol/L). (31) For fluconazole-resistant infections, itraconazole or posaconazole suspension is recommended. (37)(79) Amphotericin B is recommended when other treatment options fail. (37)

Esophageal candidiasis must always be treated systemically and oral fluconazole is recommended. (37) For patients who cannot complete oral therapy, intravenous fluconazole or an echinocandin (eg, micafungin, caspofungin, anidulafungin) are options, with amphotericin B less preferred. For fluconazole-resistant infections, itraconazole, voriconazole, amphotericin B, or an echinocandin may be used. (37) In recurrent infections or CMC, suppressive therapy with fluconazole has been found to be effective. Children who have HIV infection also should be treated with highly active antiretroviral therapy to reduce recurrent infections. (31) Proper treatment is important because untreated MC may lead to a more severe, invasive infection.

Summary

- On the basis of strong evidence, tinea capitis is the most common fungal skin infection in children. (6)(7)
- On the basis of strong evidence, treatment for tinea capitis must be systemic to penetrate the hair shafts. (17)
- On the basis of consensus, diagnosis of fungal skin infections often can be confirmed through potassium hydroxide microscopy or a culture, although cultures are of limited use for tinea corporis, pityriasis versicolor, and mucocutaneous candidiasis.
- On the basis of consensus, topical corticosteroids eventually worsen tinea corporis infections and should not be used.
- On the basis of consensus, the feet should be examined for tinea pedis and possibly onychomycosis in a child or adolescent presenting with tinea cruris. (54)
- On the basis of evidence and consensus, waiting a short period of time may allow resolution of symptoms resembling onychomycosis (ie, from trauma) because children have thinner nail plates and faster growing nails.

References for this article are at <http://pedsinreview.aappublications.org/content/38/1/8>.

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1. A 2-year-old African-American boy presents to your office with a 1-month history of an enlarging lesion on his head. On physical examination, you note a 3-cm in diameter lesion that is boggy and has overlying pustules in the occipital area. There is some shotty posterior cervical and occipital lymphadenopathy that is not tender. His mother denies the child having any fevers but notes that he seems uncomfortable when the area on his head is touched. You suspect a kerion. What is your next step in management?
 - A. Begin treatment with a systemic antifungal medication pending kerion culture results.
 - B. Observe the skin lesion for 1 month.
 - C. Obtain a skin biopsy of the skin lesion before beginning any treatment.
 - D. Perform a Wood's light examination of the lesion to see if the fungus fluoresces.
 - E. Send a skin scraping for polymerase chain reaction.
2. You diagnose tinea capitis in a 14-year-old boy who presented to your clinic with a small area of alopecia with associated scaling and erythema. Your diagnosis is confirmed with potassium hydroxide microscopy and culture. You give the parents a prescription for the appropriate systemic antifungal medication. The parents ask about whether this condition is contagious to other children. Of the following, what would the best response be?
 - A. A follow-up skin culture must be performed in 2 weeks and if it does not show fungus, the child may then return to school.
 - B. All children in the household plus any other children who are close contacts should begin prophylactic antifungal therapy.
 - C. Once treatment is begun, the child may return to school but should not share combs or helmets or play contact sports for 14 days to avoid transmission.
 - D. The child should avoid contact with infants younger than age 1 year during therapy.
 - E. The child should not be allowed to return to school until treatment is complete.
3. A father brings his 5-year-old daughter to your office with concerns about an itchy rash that developed over her face and body a few days after beginning therapy for tinea capitis. Her vital signs show temperature of 98.4°F (36.9°C), heart rate of 98 beats/min, respiratory rate of 26 breaths/min, and blood pressure of 100/55 mm Hg. Over her cheeks and trunk, you note a papulovesicular rash that seems to be slightly pruritic. You also note a small area of tinea capitis on her left temporal area. There are some broken hair shafts visible with mild scaling and erythema of the skin but no discharge. Of the following, what is the most likely explanation for her new symptoms?
 - A. A dermatophytid reaction.
 - B. A viral exanthem.
 - C. Drug reaction to the antifungal.
 - D. Pityriasis rosea.
 - E. Tinea corporis.
4. You are examining a 15-year-old boy who is a varsity wrestler at his high school. He is complaining of pruritus and erythema in his groin area for 2 weeks. On physical examination, his vital signs are all within normal limits. He has large areas of scaling with scattered overlying papules and areas of maceration on his upper medial thighs bilaterally. You are concerned about tinea cruris. Of the following, which additional condition is often associated with tinea cruris?
 - A. Inverse psoriasis.
 - B. Nummular eczema.
 - C. Onychomycosis.
 - D. Systemic candidiasis.
 - E. Tinea pedis.

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5. An 11-year-old girl presents to your office with a chief complaint of white patches inside her mouth and some difficulty swallowing. Her mother reports that the child just finished 5 weeks of antibiotic therapy for osteomyelitis of her right tibia. Her vital signs are within normal ranges. Mouth examination shows several patches of white plaques on her inner cheeks with underlying erythema. There are similar lesions in her posterior oropharynx extending inferiorly toward her esophagus. What is your best initial choice for treatment at this time?
- A. Amphotericin B.
 - B. Clotrimazole troches.
 - C. Fluconazole.
 - D. Griseofulvin.
 - E. Terbinafine.

Parent Resources from the AAP at HealthyChildren.org

- Tips for Treating Viruses, Fungi, and Parasites: <https://www.healthychildren.org/English/health-issues/conditions/treatments/Pages/Tips-For-Treating-Viruses-Fungi-and-Parasites.aspx>
- Thrush and Other Candida Infections: <https://www.healthychildren.org/English/health-issues/conditions/infections/Pages/Thrush-and-Other-Candida-Infections.aspx>
- Fungal Diseases: <https://www.healthychildren.org/English/health-issues/conditions/infections/Pages/Fungal-Diseases.aspx>
- Tinea Infections (Ringworm, Athlete's Foot, Jock Itch): <https://www.healthychildren.org/English/health-issues/conditions/skin/Pages/Tinea-Infections-Ringworm-Athletes-Foot-Jock-Itch.aspx>

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