Chapter 3
Candidiasis and Dermatophytosis: Infections and Their Prevention

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3.1 Candidiasis

3.1.1 Introduction

The *Candida* species are the most opportunistic infections of the yeast throughout the globe. The most common among being the species of the genus *Candida albicans*. Even though this species of yeast is responsible for about 50–90% of human candidiasis, *Candida albicans* is part of the commensal flora of more than half of the healthy population. The colony formation by this yeast provides benefit to the host organism also because this limits the growth of many other fungi, and it also promotes the functioning of the immune system (Vazquez-Gonzalez et al. 2013; Brunke and Hube 2013). In the last two decades, a considerable increase in the incidence of deep fungal infections has been observed, not only in immune compromised patients but also related to nosocomial infections, and even in healthy population (Eggimann et al. 2003; Raman et al. 2013; Li et al. 2006). Thus, with the increased incidence of deep fungal infections (chronic candidiasis), the primitive idea that they were related to a restrict number of pathogenic fungi and specific geographical area was completely changed. Furthermore, with the rapid increase in candidiasis incidence, other *Candida* species and microorganisms besides *C. albicans* have been involved in such infections (McCullough et al. 1999; Lott et al. 2005). The balance between *C. albicans* and non-*Candida albicans Candida* (NCAC) species determines the profiles associated with virulence. So, the most common species are *C. albicans, C. tropicalis, C. glabrata, C. dubliniensis, C. parapsilosis, C. orthopsilosis, C. metapsilosis, C. krusei, C. famata, C.*

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guilliermondii and *C. lusitaniae*. Another relevant fact associated with virulence is their capacity to form biofilms with other species, which together with the presence of teleomorph forms (sexual phase of fungi in which the same biologic entity could have two different scientific names), makes the treatment difficult and alters the susceptibility profiles to traditional antifungal agents (Kim and Sudbery 2011; Ferreira et al. 2013; Silva et al. 2010).

3.1.2 Types of Candidiasis

3.1.2.1 Genital Candidiasis

The most common infection to the genital system is the vulvo-vaginal candidiasis (VVC). It is estimated that about 75% of women experience, at least once in their lifetime, an episode of vulvo-vaginal candidiasis, 40–50% experience at least one additional episode of infection, 20–50% remain without any clinical manifestation, and, 5% experience recurrent VVC episodes (Sobel 2007; Mayer et al. 2013). Although not being a threat to life, it is unpleasant and problematic, causing a variable degree of itching and whitish discharge, abundant, and flocculent. This infection is very common in pregnant women, especially in the last trimester of pregnancy, when a variation in progesterone, estradiol, and glycogen, associated with an increase in vaginal pH, favors the emergence of these infections. In this case, special attention should be given due to the potential occurrence of contamination of the fetus in the uterus, or even the child during childbirth. On the other hand, it has been observed that, in individuals with diabetes, the incidence of vaginal candidiasis is higher. Similarly, patients submitted to broad spectrum of antibiotic therapy, used to treat bacterial infections, and even the use of oral contraceptives, are also important factors associated with higher rates of incidence of VVC (Tarry et al. 2005; Geiger et al. 1995; Ahmad and Khan 2009). In men, balanitis, which usually appear after sexual contact, is characterized by the appearance of a rash, more or less prickly, followed by small pustules on rocking groove-preputial discharge, more or less abundant. Although this kind of injury is well defined, in particular cases, it can extend to the groin and perianal region. The major factors associated with this type of infections are antibiotic therapies, diabetes, and vaginal secretions of the sexual partner (David et al. 1997).

3.1.2.2 Intrauterine Candidiasis

During pregnancy, the intrauterine infection of candidiasis is frequent. It is important to avoid the occurrence of this type of intense vaginitis in the last few weeks of pregnancy, because it can complicate and extend to the uterus, infecting the child before birth. At childbirth, or in the first hours of life, it can be observed a widespread rash, maculopapular or pustular–vesicular. During the following weeks after

birth, the clinical status may be complicated, extending to other body locations, which usually are treated with local antibiotics (Rad et al. 2011; Longe 2005).

3.1.2.3 Anal Candidiasis

Anal candidiasis is an infection characterized by strong itching/pruritus, accompanied by burning sensation and localized erythema around the anus. Skin may appear macerated with circumscribed lesions, which may eventually invade the intergluteal groove (McGirt and Martins 2004; de Wet et al. 1999). This type of infection is most common in children, despite the frequency in women due to the use of hormonal contraceptives, intimate hygiene products, clothing, and their practice of oral and anal intercourse, functioning as transient colonization of local organisms shed from the intestinal tract. As candidiasis can be sexually acquired, males can be affected, because they may acquire infection from the gastrointestinal tract of their partners. However, in some cases, the factors causing that condition are still unknown, but seems that the main problem of this pathogenesis are secondary infections caused by aerobic and facultative anaerobes microorganisms, such as *Staphylococcus* spp., *Streptococcus* spp., and *Escherichia coli* (David et al. 1997; Mardh et al. 2003).

3.1.2.4 Nail Candidiasis

Candida species are not considered normal yeasts on nail flora. Therefore, this type of infection is a sign of colonization (secondary growth) despite primary infections of nail fold and nail bed with *Candida* species may also occur, which are related to a disease of the nails. Onychodystrophy or periungual tissue is related to nail disease. This type of infection may appear, such as paronychia and onychia. The paronychia is characterized by an inflammation, more or less painful, in peripheral skin nail, which appears red and brilliant. The predisposing factors are essentially sex, different traumas (e.g., in manicure), professional activity, and hormonal variations. Although infrequent in males, this infection can appear in cooks, confectioners, and employees of canning factories (Vazquez-Gonzalez et al. 2013; Develoux and Bretagne 2005). Usually, the nail injury itself, or onyxis (ingrown nail), is secondary to paronychia. It is characterized by a progressive striation, dyschromias (discoloration) and opacity of the nail plate, which ultimately becomes crumbly. This infection appears abruptly and painfully, leading to detachment of the nail, and can spread to other nails. Still, it can be observed fungal colonization in interdigital areas, by *Candida* species, commonly known as digital intertriginous. Preferentially, it is located in the hands and between the ring and middle fingers, although it can also appear in the corners of the fingers. It is commonly associated with professions or occupations in which there is a frequent contact with water. The injury erythema – scaly, itchy, and exudative – generally is well delimited peripherally, and the epidermis appears detached. It is less frequent in feet, but can reach one or more commissures of fingers (Vazquez-Gonzalez et al. 2013; Develoux and Bretagne

2005; McGirt and Martins 2004). Intertriginous can still be located at the level of the submammary, mainly in obese women, suprapubic fold, groin and intergluteal cleft. It is characterized by the appearance of small vesicles and pustules, which, by breakage, give rise to exudative red spots [1].

3.1.2.5 Oral Candidiasis

Oral and perioral candidiasis is a more common type of acute mucocutaneous candidiasis. This infection is characterized by the presence of small spots or whitish papules on the tongue, inside the cheeks and in the palate, forming a creamy and very adherent layer mucosa. In some cases, it may extend up and cover the tongue, palate, and pharynx. It can also reach up to the corners of the mouth. When this happens, it is labeled as angular cheilitis, being evidently a mucosal thickening and cracking. This type of candidiasis particularly affects people with immune system disorders and people with dental prostheses. It can be also found in patients receiving chemotherapy for cancer treatment or taking immunosuppressive drugs to protect transplanted organs or in patients infected by HIV. In children and young people, it may be involved with oral ("thrush") and lingual disease. In addition, and despite being very rare, esophageal candidiasis can occur in patients infected by HIV and cancer (Okada et al. 2013; Dronda et al. 1996; Jin et al. 2004).

3.1.3 Predisposing Factors

Although *Candida* species is commensal to human organism and virtually present in healthy people, in the past two decades, an abnormal overgrowth in the gastrointestinal (GI), urinary, and respiratory tracts has been observed [2, 3, 6, 10, 56]. During some days after childbirth, that species colonize the mucosa of GI tract (40–50%) and upper respiratory passages, as well as the mouth, pharynx, and larynx. Normally, *C. albicans* lives smoothly in the inner warm creases and crevices of the GI tract (and vaginal tract in women). During pregnancy, *Candida* species colonization increases 30–40%, depending upon altered immune response, bacterial flora, positive variations in glycogen, and pH levels; however, mostly during the normal life cycle, other factors can affect, such as hygiene and oral contraceptive use, which contributes to 5–30% of the infections. In men, up to 10% of these species are found on the genitalia, in the transitional zone, between the mucous membrane and the skin (Longe 2005; Asmundsdottir et al. 2009). The overgrowth of C. albicans is an important cause of a wide variety of symptoms that affect directly the well-being of individuals, and therefore, there is an urgent need to recognize candidiasis as a complex medical syndrome and evaluate the magnitude of the problem regarding prevention, which passes through the control of risk factors. There are several factors that contribute to yeast infection, which means that candidiasis, and more especially chronic candidiasis, is a good example of a multifactorial

syndrome. In the next steps, the major and most important factors are explained, namely, decreased digestive secretions, dietary factors, nutrients deficiency, impaired immune system and underlying disease states, impaired liver function, drugs and prolonged use of antibiotics, and altered bowel flora.

3.1.4 Diagnosis

The diagnosis of the different types of infection of candidiasis cannot be made because the signs and symptoms are different with respect to the age, gender, resistance of the host, and exposure to environmental factors. However, there are some tools that can be used in the diagnosis and screen the infections of the yeast, namely, comprehensive digestive stool analysis (CDSA), laboratorial techniques, and questionnaire.

3.1.5 Signals and Symptoms

Despite fungi and other microbials being widespread in the environment, the systemic infections thrive very slowly. Most of the times, the individual infected does not have symptoms or visible signals. According to some authors, oral candidiasis is classified considering the following aspects: duration (acute or chronic), clinical features, color (erythematous/atrophic), location (median rhomboid glossitis, denture stomatitis, multifocal candidiasis, and angular cheilitis), presence of skin lesions, as well as oral lesions (mucocutaneous) and association with an immune compromised host (HIV associated). Other clinical aspects included hyperplastic or hypertrophic appearance, characterized by papillary hyperplasia of the palate, candida leukoplakia, and hyperplastic median rhomboid glossitis (Balch and Stengler 2004; Balch 2006).

3.1.6 Prevention

Considering the facts described above, and being *C. albicans* a commensal microorganism and that is present in all people, it is important to control the number and magnitude of its population. As prevention is the most effective treatment, much more than the eradication of the yeast with antifungal agents – synthetic or naturals – it is fundamental to address and amend the predisposing factors. Therefore, maintaining a good personal hygiene is essential. Moreover, being woman more prone to this kind of infection, a good vaginal and oral hygiene is essential, in order to reduce the probability of candidiasis occurrence (Balch and Stengler 2004; Balch 2006). Since deep infections have been increasing, mainly in hospitals, the

following aspects should be considered: probes and catheters should be regularly monitored and removed, as soon as possible, and the frequency, duration, and amplitude of the quantities of antibiotics should be kept to a minimum (Wroblewska et al. 2002; Tamura et al. 2007). Not less important is to avoid certain risk factors, such as diets rich in sugar and poor in vitamins and minerals, or the use of antibiotics.

3.1.6.1 Alternative Treatment

Candida albicans is an opportunistic yeast that cause infectious but, in some levels, lives and grows inside most human bodies. In normal situations, *Candida* is not harmful because our bodies are able to keep it under control, mainly by immune cells and probiotic bacteria. However, some factors previously discussed, such as allergies, high-sugar diets, medications/drugs, and other factors that directly affect the normal balance of intestinal environment, can kill the friendly bacteria and stimulate the overgrowth of pathogenic microorganisms (Rehaume et al. 2010; Garcia-elorriaga and Rey-pineda 2013; Isolauri et al. 2002). Therefore, the best complementary treatment is to reduce and control *Candida* levels. Several recommendations/interventions are necessary according to each person. In most of the cases, direct therapy for *Candida* species destruction is advantageous, because it assists the body on lowering *Candida* species to controllable levels (Balch and Stengler 2004; Balch 2006).

3.2 Dermatophytosis

Dermatophytes are generally referred to as the group of fungus that mostly causes skin disease in animals and humans. *Microsporum, Epidermophyton,* and *Trichophyton* are the three genera of this group. There are about 40 species in these three genera. Dermatophytes obtain nutrients from keratinized material. The organisms colonize the keratin tissues causing inflammation as the host responds to metabolic by-products. Colonies of dermatophytes are usually restricted to the nonliving cornified layer of the epidermis because of their inability to penetrate viable tissue of an immune competent host. Invasion does elicit a host response ranging from mild to severe. Acid proteinases, elastase, keratinases, and other proteinases reportedly act as virulence factors. The development of cell-mediated immunity correlated with delayed hypersensitivity and an inflammatory response is associated with clinical cure, whereas the lack of or a defective cell-mediated immunity predisposes the host to chronic or recurrent dermatophyte infection.

There are various types of dermatophyte infections including *Tinea pedis, Tinea cruris, Tinea corpora, Tinea faciei, Tinea capitis,* and *Tinea manuum*. *Tinea pedis* or athlete's foot affects not solely athletes. It affects men more than women; it can be seen initially affecting the webs between the toes, before spreading to the sole of the foot in a "moccasin" pattern. *Tinea cruris* or jock itch of the feet is also involved.

The truth is that the feet get infected first from contact with the ground. The fungus spores are carried to the groin from scratching, from putting on underclothing or pants and frequently extend from the groin to the perianal skin and gluteal cleft. Tinea corpora or ringworm of the body appears red, scaly patches with well-defined, raised edges, central clearing and itchy. *Tinea faciei* or facial ringworm can be misdiagnosed for other conditions such as psoriasis and discoid lupus. It is aggravated by treatment with topical steroid or immunosuppressive creams. *Tinea capitis* or black dot ringworm infects the hair shafts where they are broken off just at the base, leaving a black dot just under the surface of the skin. *Tinea capitis* cannot be treated topically and must be treated systemically with antifungals. *Tinea capitis* or scalp ringworm is the most common cause of *Trichophyton tonsurans* in children and is the main cause of endothrix (inside hair) infections. *Trichophyton rubrum* is also a very common cause of favus, a form of *Tinea capitis* in which crusts are seen on the scalp. *Tinea manuum* or ringworm of the hands is mostly the case of *Tinea manuum*; only one hand is involved. Subsequently both feet are involved concurrently, thus the saying "one hand, two feet." The simultaneous presence of more than one type of dermatophyte infection is common (e.g., *Tinea pedis* and *Tinea cruris* or *Tinea pedis* and *Tinea unguium*). Performance of a full skin examination including the skin, hair, and nails aids in the detection of additional sites of infection. Occasionally, patients develop a dermatophytid reaction, a secondary dermatitic reaction at a distant site that may reflect an immunologic reaction to the infection.

3.2.1 Treatment

Topical or systemic antifungal drugs with anti-dermatophyte activity are effective therapies. Most superficial cutaneous dermatophyte infections can be managed with topical therapy with agents such as azoles, allylamines, butenafine, ciclopirox, and tolnaftate. Nystatin, an effective treatment for *Candida* infections, is not effective for dermatophytes. Oral treatment with agents such as terbinafine, itraconazole, fluconazole, and griseofulvin is used for extensive or refractory cutaneous infections and infections extending into follicles or the dermis (e.g., Majocchi's granuloma) or involving nails. Patients should not be treated with oral ketoconazole because of risk for severe liver injury, adrenal insufficiency, and drug interactions.

Although they can be effective and may accelerate resolution of the clinical manifestations of superficial dermatophyte infections, use of combination of antifungal and corticosteroid products that include medium- or high-potency corticosteroids (e.g., clotrimazole 1% betamethasone dipropionate 0.05%) is discouraged because corticosteroid therapy is not necessary for achieving cure and use of a topical corticosteroid introduces risk for topical corticosteroid-induced skin atrophy. Treatment failures have also been reported. On the other hand, immunosuppression may increase risk for dermatophyte infection and may contribute to the development of extensive or persistent disease. The possibility of an underlying immune disorder

should be considered in patients with particularly severe or treatment refractory disease.

Treatment is recommended to alleviate symptoms (pruritus), reduce risk for secondary bacterial infection, and limit spread of the infection to other body sites or other individuals. Topical antifungal therapy is the treatment of choice for most patients. Systemic antifungal agents are primarily reserved for patients who fail topical therapy. Topical drugs effective for *Tinea pedis* include azoles, allylamines, butenafine, ciclopirox, tolnaftate, and amorolfine. Amorolfine is not available in the United States. A meta-analysis of randomized trials published prior to February 2005 supports efficacy of topical therapy, finding strong evidence of superiority of topical antifungal agents (azoles, allylamines, ciclopirox, tolnaftate, butenafine, and undecanoate) over placebo. Allylamines may be slightly more effective than azoles; a meta-analysis of data from 11 trials that compared topical allylamines to topical azoles found slightly higher cure rates with allylamines (risk ratio of treatment failure 0.63, 95% CI 0.42–0.94). Topical antifungal treatment is generally applied once or twice daily and continued for 4 weeks. Shorter treatment courses may be effective; high cure rates have been obtained with terbinafine 1% cream applied to interdigital *Tinea pedis* for 1 week.

Patients requiring oral antifungal therapy are usually treated with terbinafine, itraconazole, or fluconazole. Griseofulvin can also treat *Tinea pedis*, but may be less effective than other oral antifungals and requires a longer duration of therapy. In a systematic review, terbinafine was found more effective than griseofulvin, while the efficacy of terbinafine and itraconazole were similar. Typical adult doses for griseofulvin for *Tinea pedis* are 1000 mg per day of griseofulvin microsize for 4–8 weeks or 660 or 750 mg per day of griseofulvin ultramicrosize for 4–8 weeks. Dosing for children is weight based with durations of treatment similar to adults.

Patients with hyperkeratotic *Tinea pedis* can benefit from combining antifungal treatment with a topical keratolytic, such as salicylic acid. Burow's (1% aluminum acetate or 5% aluminum subacetate) wet dressings, applied for 20 minutes two to three times per day or placing gauze or cotton between toes may be helpful as an adjunctive measure for patients with vesiculation or maceration. Interventions that may help to reduce recurrences include use of desiccating foot powders, treatment of shoes with antifungal powder, and avoidance of occlusive footwear.

In some cases, systemic treatment is an alternative for patients with extensive skin involvement and patients who fail topical therapy. Terbinafine and itraconazole are common treatments. Griseofulvin and fluconazole can also be effective, but they may require longer courses of therapy. Randomized trials support the efficacy of systemic therapy.

Leaves of *Catharanthus roseus* showed antifungal activity against *Microsporum gypseum, Trichophyton simii,* and *Malbranchea gypsea* or *Chrysosporium tropicum* and *C. tropicum*. In vitro antifungal activity was investigated by using different organic solvent of lemon, nerium, olive oil, and basil against *Microsporum canis, Microsporum gypseum, Trichophyton mentagrophytes, T. verrucosum,* and *Epidermophyton floccosum*. Plants of *Allium sativum, Cymbopogon martinii,* and *Catharanthus roseus* were screened for their antimycotic activity by using disc

diffusion method. Water extract methanol, free flavonoids, and bound flavonoids of various plants were tested against *Trichophyton rubrum, T. mentagrophytes,* and *Microsporum gypseum.* Free flavonoid and bound flavonoid extracts showed maximum inhibitory effect against pathogenic fungal species.

Antifungal activity of *Ranunculus sceleratus* and *Pongamia pinnata (P. pinnata)* was tested for anti-ringworm activity of five strains *Trichophyton rubrum, T. mentagrophytes, T. tonsurans, Microsporum gypseum,* and *Microsporum fulvum*. Leaves of *Calotropis* spp. were evaluated against *Trichophyton rubrum, T. tonsurans, T. mentagrophytes, Epidermophyton floccosum,* and *Aspergillus flavus* which showed antimycosis activity. In vitro antifungal activity of *Azadirachta indica L., Cassia tora L.,* and *Lawsonia inermis L.* against three human pathogenic fungi, *Trichophyton rubrum, Trichophyton mentagrophytes,* and *Epidermophyton floccosum*. In vitro antifungal activity of different synthetic, herbal shampoos and natural products were tested against clinical isolated species like *Malassezia, Trichophyton,* and *Aspergillus* spp. Synthetic shampoos showed excellent inhibitory activity against *Trichophyton, Malassezia* spp., *Aspergillus flavus,* and *Aspergillus niger*.

Leaves of *Eucalyptus rostrata* show antidermatophytic activity against four fungi *Trichophyton mentagrophytes, Epidermophyton floccosum, Microsporum gypseum,* and *M. canis*. Leaves of neem also showed the antidermatophytic activity against 88 clinical isolates of dermatophytes. Leaf extract of *Pistia scleratus* showed antidermatophytic activity against *Trichophyton rubrum*, *Trichophyton mentagrophytes, Microsporum gypseum, Microsporum nanum,* and *Epidermophyton floccosum*. Hydro-alcoholic extract of *Eucalyptus camaldulensis* was tested against dermatophytes by using in vitro dilution technique.

Drynaria quercifolia used by tribals in Maharashtra was tested for antidermatophytic activity against *Trichophyton mentagrophytes, Microsporum canis, M. gypseum, T. rubrum,* and *Epidermophyton floccosum* by using agar dilution and disc diffusion method. The ethanol extracts isolated by thin layer chromatography was found to possess antidermatophytic activity with clear zone due to presence of triterpenes and coumarins (antifungal compounds). Root extracts of *Solanum dulcamara* were found to possess anti-dermatophytic activity against *Trichophyton rubrum, T. mentagrophytes,* and *Microsporum gypseum.* The best activity of root extract was found against *Microsporum gypseum* with inhibition zone of *Trichophyton mentagrophytes* which was found to be larger than ketoconazole. *Curcuma* species were screened for antidermatophytic activity of *Trichophyton rubrum* and *Microsporum canis* by broth dilution method. *Mentha piperita* leaves were tested in vitro against two species of *Trichophyton* and *Microsporum canis*. Ethanolic extract of leaves of *Mentha piperita* exhibited the strongest activity against *Trichophyton rubrum* and *Microsporum canis*.

Calotropis procera leaf extracts were tested against three different genera of dermatophytes, namely, *Microsporum, Trichophyton,* and *Epidermophyton,* by dilution agar method. The ethanolic extract of *Calotropis procera* leaves was found to be inhibited in all the species of dermatophytes. Various extracts of neem *(Azadirachta indica)* leaves possess antidermatophytic activity against dermatophytes isolated

from patients with dermatophytosis. India is rich in medicinal plants with antidermatophytic activity.

3.2.2 Communicability

Dermatophytes acquired from animals can be transmitted between people, but this is uncommon and the number of transfers is limited. In contrast, anthropophilic dermatophytes are readily spread from person to person. Anthropophilic dermatophytes can be transmitted to animals, although this seems to be rare.

3.2.3 Diagnostic Tests

Diagnosis is based on the history, physical examination, and microscopic examination of scrapings and hairs from the lesions, sometimes in conjunction with fungal culture and other techniques such as Wood's lamp examination and histology of the tissues. Some dermatophytes fluoresce when they are stimulated by the wavelengths of ultraviolet (UV) light in a Wood's lamp. Organisms that exhibit fluorescence include some strains of the zoophilic dermatophytes *M. canis* and *T. quinckeanum*, as well as a few anthropophilic species, such as *M. audouinii, T. tonsurans,* and *T. violaceum*, which are the most common agents in some regions, are not revealed by this technique. Certain topical preparations may mask the fluorescence, and alcohol can either suppress it or cause nonspecific fluorescence. Dermatophytes can often be detected by microscopic examination of infected hairs and skin or nail scrapings. Hyphae rounding up into arthroconidia are diagnostic, but hyphae alone could be caused by other fungi, including contaminants. In hairs, arthroconidia may be found outside (ectothrix) or inside (endothrix) the hair shaft. Skin scrapings should be taken from the edge of the lesion, and hairs should be plucked (not cut) from this area. The best hairs to select are those that fluoresce under a Wood's lamp or are broken or scaly. Nail scrapings are generally taken from the nail bed or from deeper portions of the nail after removing the outer layers (except in cases where the infection is entirely superficial). Samples are usually cleared with potassium hydroxide (KOH) or other agents to help visualize the organism. Various stains such as chlorazol black E, Parker blue–black ink, Swartz–Lamkin stain, or Congo red stain may be added. Fluorescence microscopy, using calcofluor white or other stains, can also be used to visualize dermatophyte structures. Fungal cultures, which identify the species of dermatophyte, can be useful in understanding the source of the infection and targeting preventive measure appropriately. Culture may also be necessary if the diagnosis is uncertain, or the infection is resistant to standard treatment. However, recommendations vary in the literature, and uncomplicated cases are not always cultured in practice. Samples for culture include hair, skin, and nail samples, as for microscopic examination. In some situations (e.g., infections in

sensitive sites or the identification of asymptomatic carriers), other techniques such as brushing the hair, using adhesive tape to collect samples, or rubbing the area with a sterile toothbrush or moistened, sterile cotton swab may also be effective. Colonies appear in 5 days to 4 weeks, depending on the organism. Colony morphology can differ with the medium. Descriptions are usually based on Sabouraud agar, but dermatophyte medium or other fungal culture media can also be used for isolation. Dermatophyte species can be identified by the colony morphology; the appearance of microconidia, macroconidia, and other microscopic structures; biochemical characteristics such as urease production; and nutritional requirements. Specialized tests such as the ability to penetrate hairs in vitro or mating tests (which are usually available only at reference laboratories) may be used occasionally. Differential media (e.g., bromocresol purple-milk solids glucose) can be helpful during differentiation. Some fungal cultures from infected people are negative. Histology (biopsy) is occasionally helpful, especially in deep mycoses and some infections of the nails. The organisms are visualized best with periodic acid–Schiff (PAS) staining, although they may also be found in hematoxylin–eosin-stained preparations. PCR tests have been published for a number of organisms, and molecular methods of diagnosis might become more common in the future.

3.3 Prevention

Controlling dermatophytes in animals can prevent some cases of zoonotic dermatophytosis in humans. Infected animals should be treated, and the premises and fomites cleaned and disinfected as much as possible. (Some environments can be difficult to decontaminate.) Contact with infected animals should be limited, and gloves and protective clothing should be used if these animals are handled. Better surveillance, improved living conditions, and improved treatments can decrease the overall prevalence of anthropophilic dermatophytes, while hygiene and prevention of contact are helpful in individual cases. Measures such as moisture control (e.g., in *Tinea pedis*) are important in reducing susceptibility to some forms of *Tinea*.

3.4 Conclusion

All people are exposed to a variety of candidiasis predisposing factors, and some of them are impossible to avoid. *Candidiasis* can affect different parts of the body (nails, GI tract, and vagina, among others) being characterized by several symptoms, which is often difficult to diagnose; additionally, the individual characteristics alter the manifestation of signals and symptoms. As this infection is very uncomfortable and, in some cases, offers a considerable health risk, the major and most important aspect is prevention. Therefore, there are several aspects to consider and include in the daily routine, which at first might seem in significant, but that could

provide a strength protection. To combat the infection, different procedures are necessary according to the pathologic conditions of the patient; if all daily care is considered, the probability of the infection occurrence will be considerably reduced. However, in face of an infection, a rapid intervention is necessary, and for this, other alternatives to antifungals and antimicrobials are necessary.

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