pteropid bats (Egyptian rousettes) have been identified as healthy carriers of MARV and RAVV. Avoidance of direct or indirect contact with these bats is therefore useful advice to people entering or living in areas where the animals can be found. Prevention seems to be more difficult in the case of ebolaviruses, for which definite reservoirs have not yet been pinpointed. EVD outbreaks have been associated not with bats but rather with hunting or consumption of nonhuman primates. The mechanism of introduction of ebolaviruses into nonhuman primate populations is unclear. Therefore, the best advice to locals and travelers is to avoid contact with bush meat, nonhuman primates, and bats.

Relatively simple barrier nursing techniques, vigilant use of proper personal protective equipment, and quarantine measures usually suffice to terminate or at least contain filovirus disease outbreaks. Isolation of filovirus-infected people and avoidance of direct person-to-person contact without proper personal protective equipment usually suffice to prevent further spread as the pathogens are not transmitted through droplets or aerosols under natural conditions. Typical protective gear sufficient to prevent filovirus infections consists of disposable gloves, gowns, and shoe covers and a face shield and/or goggles. If available, N-95/N-100 respirators may be used to further limit infection risk. Positive air pressure respirators should be considered for high-risk medical procedures such as intubation or suctioning. Medical equipment used in the care of a filovirus-infected patient, such as gloves or syringes, should never be reused unless safety-tested sterilization or disinfection methods are properly applied. Because filovirions are enveloped, disinfection with detergents, such as 1% sodium deoxycholate, diethyl ether, or phenolic compounds, is relatively straightforward. Bleach solutions of 1:100 and 1:10 are recommended for surface disinfection and application to excreta/corpses, respectively. Whenever possible, potentially contaminated materials should be autoclaved, irradiated, or destroyed.

SECTION 16 FUNGAL INFECTIONS

235 Diagnosis and Treatment of Fungal Infections

John E. Edwards, Jr.

TERMINOLOGY AND MICROBIOLOGY

Traditionally, fungal infections have been classified into specific categories based on both anatomic location and epidemiology. The most common general anatomic categories are mucocutaneous and deep organ infection; the most common general epidemiologic categories are endemic and opportunistic infection. Although *mucocutaneous infections* can cause serious morbidity, they are rarely fatal. *Deep organ infections* also cause severe illness in many cases and, in contrast to mucocutaneous infections, are often fatal. The *endemic mycoses* (e.g., coccidioidomycosis) are caused by fungal organisms that are not part of the normal human microbiota but rather are acquired from environmental sources. In contrast, *opportunistic mycoses* are caused by organisms (e.g., *Candida* and *Aspergillus*) that commonly are components of the normal human microbiota and whose ubiquity in nature renders them easily acquired by the immunocompromised host (Table 235-1). Opportunistic fungi cause serious infections when the immunologic response of the host becomes ineffective, allowing the organisms to transition from harmless commensals to invasive pathogens. Frequently, the diminished effectiveness of the immune system is a result of advanced modern therapies that coincidentally either cause an imbalance in the host's microbiota or directly interfere with immunologic responses. Endemic mycoses cause more severe illness in immunocompromised patients than in immunocompetent individuals.

TABLE 235-1 ENDEMIC AND OPPORTUNISTIC MYCOSES

Endemic Mycoses[a]	Opportunistic Mycoses
Coccidioidomycosis	Candidiasis
Histoplasmosis	Aspergillosis
Blastomycosis	Cryptococcosis
Phaeohyphomycosis	Mucormycosis (zygomycosis)
Penicilliosis	Scedosporiosis
Sporotrichosis	Trichosporonosis
Paracoccidioidomycosis	Fusariosis
	Pneumocystosis

[a]The endemic mycoses can also occur as opportunistic infections.

Patients acquire deep organ infection with endemic fungi almost exclusively by inhalation. Cutaneous infections result either from hematogenous dissemination or, more often, from direct contact with soil—the natural reservoir for the vast majority of endemic mycoses. The dermatophytic fungi may be acquired by human-to-human transmission, but the majority of infections result from environmental contact. In contrast, the opportunistic fungus *Candida* invades the host from normal sites of colonization, usually the mucous membranes of the gastrointestinal tract. In general, innate immunity is the primary defense mechanism against fungi. Although antibodies are formed during many fungal infections (and even during commensalism), they generally do not constitute the primary mode of host defense. Nevertheless, in selected infections, as discussed below, measurement of antibody titers may be a useful diagnostic test.

Three other terms frequently used in clinical discussions of fungal infections are *yeast*, *mold*, and *dimorphic fungus*. *Yeasts* are seen as rounded single cells or as budding organisms. *Candida* and *Cryptococcus* are traditionally classified as yeasts. *Molds* grow as filamentous forms called *hyphae* both at room temperature and in invaded tissue. *Aspergillus*, *Rhizopus* (the genus that causes mucormycosis, also known as zygomycosis), and fungi commonly infecting the skin to cause ringworm and related cutaneous conditions are classified as molds. Variations occur within this classification of yeasts and molds. For instance, when *Candida* infects tissue, both yeasts and filamentous forms may be present (except with *C. glabrata*, which forms only yeasts in tissue); in contrast, *Cryptococcus* exists only in yeast form. *Dimorphic* is the term used to describe fungi that grow as yeasts or large spherical structures in tissue but as filamentous forms at room temperature in the environment. Classified in this group are the organisms causing blastomycosis, paracoccidioidomycosis, coccidioidomycosis, histoplasmosis, and sporotrichosis.

The incidence of nearly all fungal infections has risen substantially. Opportunistic infections have increased in frequency as a consequence of intentional immunosuppression in organ and stem cell transplantation and other disorders, the administration of cytotoxic chemotherapy for cancers, the liberal use of antibacterial agents, and, more recently, the increasing use of monoclonal antibodies.

Within a global context, the incidence of endemic mycoses has increased in geographic locations where there has been substantial population growth. When advances in medical care (e.g., more aggressive treatment of cancer or organ transplantation) are introduced into a given area, the opportunistic mycoses increase in incidence.