Candida: The Unfriendly Yeast

NHS.UK

Author: Tracey Long PhD, RN, APRN
Contact hours: 1.5
Course Price: $10

As a healthcare professional, you have a role in identifying, preventing, and treating candida yeast infections. All healthcare professionals need to be involved in the assault on *albicans* and, more serious, *auris* yeast infections. This course discusses the causes and defines the types of candida yeast infections, including their clinical symptoms, treatment, and prevention strategies.

Course Objectives

When you finish this course, you will be able to:

1. List at least 6 variations of candida in the human population.
2. Describe the incidence and prevalence of candida yeast infections.
3. State the 2 populations wherein *C. auris* has been identified.
4. Identify 2 ways of diagnosing yeast infections.

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1. Defining the Enemy

Darrell, a 62-year-old male patient has been admitted to the hospital for respiratory distress after an exacerbation of his COPD during flu season. He also has uncontrolled diabetes mellitus, hypertension, and a lower lobe pneumonia. He has been on a ventilator (assist control) for five days. He is receiving antibiotics for the pneumonia.

Upon completion of the morning assessment, the nurse notices a thick white coating on his tongue and mouth and around the endotracheal tube. She plans to provide oral care several times during her shift. Later in the day she notices that the white coating on the tongue is difficult to scrape off but thinks it is just a stubborn film on his tongue. Or is it something more?

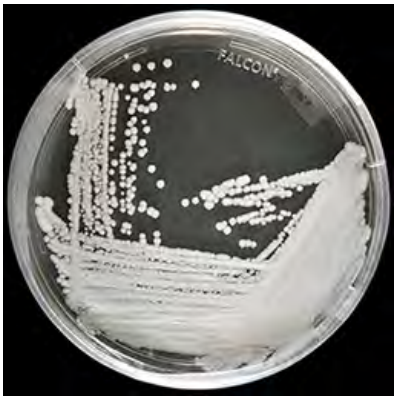
- Did you recognize the clinical signs of an oral yeast infection?
- What risk factors did Darrell have to increase the development of oral candida?
- What tests are done to diagnose candida? What are the causes?
- How is it transmitted? Is it infectious?
- What are the different types of yeast infections?
- What is the nurse's role in treating fungal infections?
- What prevention and treatment strategies are available?
- What is the role of healthcare professionals in helping people avoid common yeast infections?
- Do you have yeast in and on your body? If so, is it in control?

If you struggled to answer these questions, we will discuss each of these issues to prepare you to begin your own assault against candida yeast infections.

Yeasts That Infect

Yeast infections are also known as *fungal infections* and are caused by the fungus *candida*. Yeast are single celled organisms and classified in the biology Kingdom *Fungus*, which also includes mushrooms and molds. It is different from other microorganisms such as bacteria, protozoa, and amoeba. **Candida** is the genus level name for a fungus, and there are more than 150 different kinds of candida (McCombs, n.d.). Healthcare workers are often more familiar with ***Candida albicans***, a common fungal skin infection, but there are dozens of variations and types of fungal infections. A very serious fungus that has developed a resistance to current antifungal treatments is called ***Candida auris***. It is because of this growing threat within hospitals and for long-term care patients, that there is a need for healthcare workers to be better informed about candida.

Candida auris



Source: NHS.UK.

Most fungi dwell normally within and on-top of the human body creating a natural competitor against normal bacteria, which is also on and in the body. Candida is known as an opportunistic microbe, and given the right opportunity, candida yeast can become overgrown and cause an infection (Vázquez-González et al., 2013). When the normal human environment is disrupted, and the human immune system is diminished **candidiasis** may result. Candidiasis is any fungal infection due to any type of candida that has become out of control in the human body (Huether & McCance, 2008).

Fungal disorders are also called **mycoses** and when caused by a topical fungus affecting the epidermis, the disorder of the skin is called **tinea**. The second Latin name identifies the area of the body infected ; consider *Tinea capitus*, which is a fungal infection of the scalp; *Tinea corporis*, which is a yeast infection of the body; *Tinea pedis*, which is a fungal infection of the feet. Other names for candida include *moniliasis* and *oidomycosis*.

Candida albicans is a gram-positive budding yeast, and of more than twenty types of fungal infections it is the most common. Like other opportunistic pathologic yeast, *Candida albicans* is found in humans where ideal growth environments exist. Candida exists as normal flora in the human intestines. It grows within the gastrointestinal tract from the mouth through the small intestines and is found in the mouth of up to 60% of healthy adults (Erdogan & Rao, 2015). *Albicans* is one of the most common fungal species to be isolated on medical devices and on human tissues. It is one of several forms that cause candidiasis. The other five most common forms of candida are *C. tropicalis*, *C. parapsilosis*, *C. glabrata*, *C.krusei,* and *C. auris*, which combined are responsible for up to 90% of all human candidiasis (Martins et al., 2014*).*

Candida albicans

Source: Shutterstock.

***Candida auris*,** another type of yeast, has become **drug resistant** and is spreading in healthcare facilities, quickly becoming a serious concern. The Centers for Disease Control and Prevention (CDC) track candida infections through hospital reporting, in order to understand the transmission, incidence, and susceptibility to treatment. When any pathogen begins to become resistant to current medications, the CDC becomes actively engaged in tracking and creating standard guidelines for treatment across the nation.

Types of Common Human Yeast Infections

Name	Location	Clinical appearance	Treatment
Cellulitis from *C. auris*	Any topical skin area	Redness, heat and discomfort in affected area, poorly demarcated.	Topical antifungals
Diaper rash	Genitals and buttocks of babies	Red, warm, burning diffuse rash on buttocks and vaginal skin folds of girls.	Topical antifungal
Invasive candidiasis	Through bloodstream		Oral or IV antifungals: fluconazole, itraconazole, or amphotericin B.
Intertrigo	Yeast infection in skin folds of breast, groin and armpits.	Red, itchy, small bumps with no defined borders.	Topical or oral antifungals x 14 days.
Interface dermatitis (ID)	Rash on one part of body in response to a fungal infection elsewhere on the body.	Red, itchy, blisters on the skin	Oral antifungal
Thrush (oropharyngeal candidiasis)	Oral cavity	• White or yellow coating on tongue, lips, gums, roof of mouth and inner cheeks. • Redness and soreness in the mouth and throat. • Cracking at the corners of the mouth. Sometimes pain when swallowing.	• Oral swish and spit antifungals • Oral care/toothbrushing • Rinsing after oral glucocorticoid inhaler use • Ex. Nystatin, clotrimazole and fluconazole. • Swish with oral chlorhexidine mouthwash.

Tinea barbae	Chin and beard of men	Flaky, scaly and itchy chin. Similar to tinea corporis or ringworm.	Oral antifungals as topical creams and lotions are not effective.
Tinea capitus	Scalp	Itchy, scaly bald patches on the head.	Ketoconazole 2% shampoo
Tinea corporis (ringworm)	Epidermis of the skin anywhere on the body	• Flaky, scaly and itchy. Circle or ring-shaped with clear center. May have bumps and red patches that turn in to the shape of circles. • Small, erythematous and vesicular patches with slightly elevated border forming a ring.	Topical antifungal
Tinea cruris (jock itch) genital candidiasis	Genitals male & female	• Itchiness in the vagina, redness and swelling of the vagina and vulva. Pain and burning on urination, discomfort during sex (dyspareunia). • Thick, white "cottage-cheese" or "curd-like" discharge from vagina.	Intravaginal antifungal suppository, tablet or cream.
Tinea manis (hands)	Hands	Dry, flaky and peeling hands	Topical antifungal cream and lotions for moisturizing the dead dry skin afterwards.
Tinea pedis (onychomycosis; *Tinea unguium*)	Foot and nails of the toes	Thickened, brittle and white not clear nail. Great toe is most common. Nail bed may separate (onycholysis).	Topical and oral antifungal fluconazole 150-300 mg weekly for 2-3 months. Lamisil weekly for several weeks; terbinafine. Topicals are generally not effective.
Tinea versicolor (pityriasis versicolor)	Trunk of body front and back	Hypopigmented round macules on chest/shoulders/back; appear after skin is tanned from skin. Often asymptomatic	Topical selenium sulfide (Selsun Blue shampoo); Ketoconazole (Nizoral) BID x 2 weeks, Oral antifungals

Source: Cash & Glass (2014). Images: Wikimedia Commons. Table Design: Author.

Skin yeast infections can also appear as a red, flat rash with scalloped edges. **Satellite lesions** are extensions of the original yeast that grow to extend the rash. As noted above, tinea infections are identified by their location on the body.

Pathology of Candida

Candida are organisms that can be dimorphic or polymorphic, meaning their shape can appear as a single cell or become more pathologic with multiple extensions or filaments from a cell. Candida yeasts are part of the normal pathogens on the body, found on the skin and throughout the intestinal flora, and are kept within ideal limits by natural competition from other microorganisms such as bacteria.

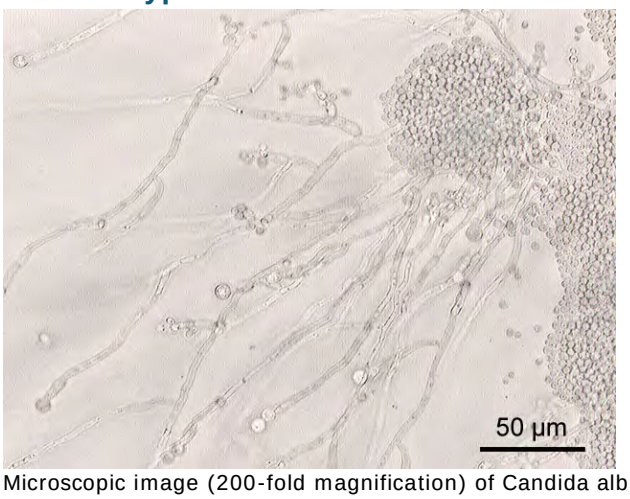
Yeast grow best in humans under conditions of warmth, moisture, and access to sugar for energy. Skin folds that are warm and moist such as the mouth, genitals, or a baby's diaper region, are ideal reservoirs for yeast growth. Skin folds of obese people, such as under breasts or armpits, are common growth areas for candida. The vagina of females is also an ideal location for yeast overgrowth given the right conditions. Yeast prefer sugar for food and grow well with diets high in sugar, such as in people with diabetes mellitus and uncontrolled blood sugar levels.

Did You Know. . .

Not all yeasts grow in warm areas; consider the mold that grows on your refrigerated food that has been kept too long.

Yeast cells can be seen in different *morphologies*, or appearances. When they appear ovoid under a microscope they are known as yeast cells. If they look like a cactus with multiple branches, they are known as **hyphae**; when they are a combination of both round cells and elongated growths, they are called **pseudo hyphae**.

Pseudo Hyphae of *Candida albicans*



Microscopic image (200-fold magnification) of Candida albicans ATCC 10231, grown on cornmeal agar medium with 1% Tween80. Source: Wikimedia Commons. GNU Free Documentation License. Source: Wikimedia Commons.

When the yeast is in round cells, the cells can move easily to different areas of the body; whereas, when they are in hyphae mode, the filaments can more easily invade surrounding body tissues and create a broader infection. Yeast generally prefers to live on the skin and mucus membranes. When it grows out of control, it impacts the squamous epithelium of the top layer of the skin. Yeast can destroy skin cells and keratin and deposit its own protein layer, which appears as a **white cottage-cheese-like appearance**, as seen in vaginal and oral infections.

As it destroys topical skin or mucus layers of the host, it is known as **pseudomembranous candidiasis.** This is more common in those with a weakened immune system, such as infants and elders; those who are immunosuppressed (such as those with diabetes or HIV/AIDS); or those taking medications that may suppress the immune system, such as inhaled steroids, chemotherapy, or radiotherapy.

Another condition is called **erythematous candidiasis**, which is due to a change in the level of competition between yeast and normal bacteria. Taking antibiotics or smoking can decrease normal colonizing levels of bacteria but not have a negative impact on yeast, so the yeast cells grow out of control. The body's normal first reaction to any overgrowth is inflammation and an increase in blood flow to the area to deliver antibodies and oxygen. The result is a reddened and painful skin area from vasodilation. The pain is due to the swelling tissues that push on the nerve endings.

When identifying characteristics of yeast, in addition to the morphology, is the existence of **adhesins**, which make the yeast stick to surface areas. Adhesins are made of glycosyl phosphatidyl inositol, which has surface sticky **glycoproteins** that allow it to adhere to the surface of other microorganisms and inorganic surfaces. **Invasins*** allow the yeast to invade other tissues such as epithelial tissues and cells of the skin.

***Invasins,** a class of proteins associated with the penetration of pathogens into host cells. Invasins play a role in promoting entry during the initial stage of infection.

In addition to the typical body locations of the mouth, esophagus, skin, and vagina, yeast becomes dangerous when growing on mechanical devices such as central venous catheters used by patients in hospital and long-term medical facilities. The candida forms a **biofilm** on the catheter and devices and can prolong a hospital stay. The biofilm can also break off and move to other areas. If it enters the bloodstream, it **can become septic** for the patient. Depending on where the mechanical device is, the yeast may have easy access to heart valves, kidneys, and the brain.

Additionally, candida secretes **hydrolases** such as protease, phospholipase, and lipase, which break down cells of the host and make it easy to penetrate and take up nutrients from the host environment. An example is intestinal candida that becomes overgrown, causing post-meal abdominal bloating and fatigue as the yeast grow and use up resources from the host.

Metabolic adaptation is flexible for candida, as they will consume energy from food sources in the gut of the host or can create new fuel through **gluconeogenesis**. When an overgrowth of yeast occurs, it is said the yeast **colonize** and then invade human tissue or mucous and can dangerously pass into the bloodstream.

Friendly Yeast

Not all yeast is bad. If you have ever baked bread from "scratch," you will recall that you add a tablespoon of baker's yeast to warm water and a tablespoon of sugar. If the water is too hot the yeast won't grow, and the mixture will make flat, hard bread. With the right temperature of warm water, in just minutes you see bubbles forming as the yeast become activated. These yeast organisms begin to digest the sugar and release gas, accounting for the bubbles. If you add salt, the reaction begins to slow down; yeasts are killed by salt, which disrupts their cell structures. Upon adding flour and other ingredients, the yeast continues to grow until it is ready to be baked. The high baking temperature kills the yeast and the growth stops.

In essence, this process of using yeast to bake bread is similar to the yeast growth within and on our own bodies. Given a warm and moist climate, yeast grow. When exposed to natural competitors, such as bacteria, yeast is held at bay. If deprived of warmth, moisture, and sugar, they cannot flourish. This process suggests strategies for prevention, which we'll discuss later.

Curative Power of Yeast: Penicillin

Now the positive side of yeast must be told. Yeast are a vital organism in the mix of our gastrointestinal normal flora that help with our digestion of food. Yeast was also key to the discovery of their effectiveness against bacteria, which can harm us. In 1928, Alexander Fleming is known for his discovery of the effectiveness of the penicillin mold against bacteria. How he discovered a "cure" against staphylococcus bacteria was due to yeast. As a Scottish bacteriologist in London, he was studying the bacteria on an agar growth plate that he placed by an open laboratory window at London's St. Mary's Hospital. Days later he realized a blue-green mold yeast, known as *Penicillium notatum*, had blown through the window and contaminated the petri dish. Upon further examination, he saw that the yeast had grown onto the bacteria and killed it and there was a clear ring or around the yeast where bacteria couldn't grow (Newman, 2019).

Believing that penicillin would not last long enough in humans to kill bacteria, he looked for help in purifying the promising drug. The research continued in 1934 at Oxford University by advanced scientists Howard Florey, Ernst Chain, and Norman Heatley, who were able to purify and test it successfully in mice, and then in humans. Thankfully, the combined efforts of scientists and yeast produced a huge blessing to mankind—penicillin, which effectively kills harmful bacterial infections. Ironically, in the Nobel Prize acceptance speech of Alexander Fleming, he warned that overuse of the penicillin may lead to bacterial resistance, which has since occurred. In summary, yeast can be both foe and friend.

Apply Your Knowledge

How would you explain both the advantages and disadvantages of yeast?

2. The Incidence and Prevalence of Candida

History of Candida

Reports of candida yeast infections have been seen in human literature for more than 2400 years; because of its multiform characteristics, it has endured for millennia. The Father of Medicine, Hippocrates, cited symptoms and treatments for fungus in 377 C.E. The most common yeast, *Candida albicans,* was first named in 1923 by doctoral student Christine Marie Berhout of the Netherlands (McCoombs, n.d.). After the discovery by Alexander Fleming of the effectiveness of penicillin yeast against bacteria, research and studies in candida have grown tremendously in the twentieth century.

As penicillin and other antibiotics became prevalent and even overused, candida infections also became more common as a side effect from removing the natural competitor of bacteria. Now as types of candida have become more threatening and resistant to antifungals (eg, *Candida auris)*, studies are searching for better solutions.

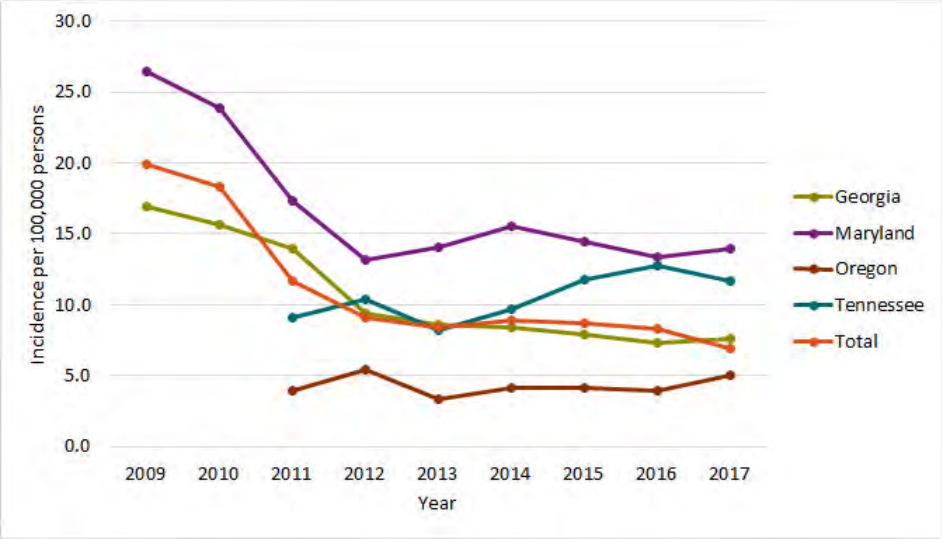
The Cost of Candida Infections

Candida albicans is known as the fourth-most overall infectious agent in hospitals (CDC, 2019c). It is also known as the most common yeast isolated from clinical specimens in superficial and systemic infections (Magill, 2018). The reported cases of candidemia and candidiasis reveal that approximately 9 per 100,000 people in the United States will develop candidemia, which is the most invasive form of candidiasis because it enters the blood. Other yeast infections of the heart, kidney, and bones may not be easily detected as they are not in the blood and, according to CDC, the statistics and incidence of candidiasis and candidemia may actually be higher.

Since 2008 the CDC has surveyed candida bloodstream infections through a program called the **Emerging Infections Program (EIP).** This includes state health departments in California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon and Tennessee, in collaboration with their local laboratories, academic institutions, and public health and healthcare facilities. The CDC and its partners receive reports from these agencies about cases of candidemia within their states. A current list of the counties within each state that are submitting reports can be found at the CDC website.

National trends revealed that the incidence of candidemia stabilized during 2009–2013 demonstrating the effectiveness of hospital policies and procedures involving catheter care (Cleveland et al., 2015). Interestingly, the trends are geographic and reveal that states with higher numbers and practices of injection drug use see higher incidences of candidemia.

Candidiasis Invasive Statistics

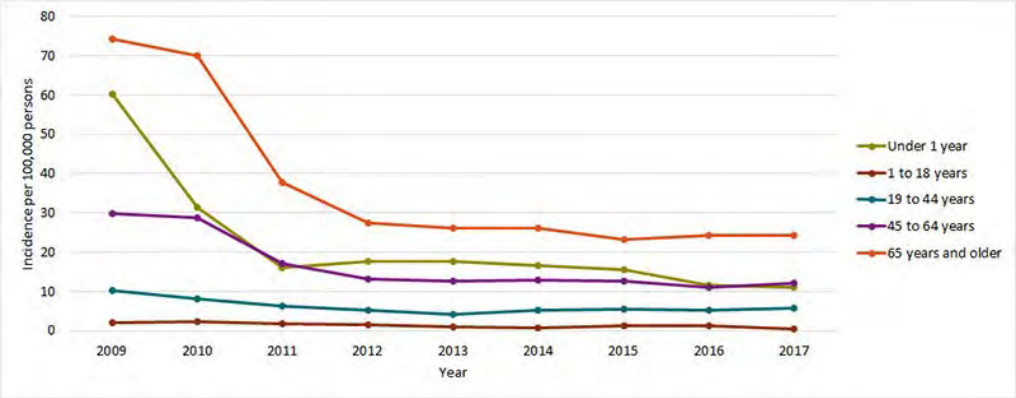


Source: CDC.

Candidemia rates are highest in adults age 65 and older and twice as high in blacks as in non-blacks (CDC, 2019c). Socioeconomic status and underlying health conditions may explain the difference. There has also been a decline in reports of candida in infants younger than 1 year old, and it is hypothesized that is due to better hand hygiene for hospitalized infants.

The species of candida also varies by geography, but generally *C. albicans* is the most common; however, since 2016 the most serious emerging species is *C. auris*. More than 70% of the fluconazole-resistant strains are *Candida glabrata* and *Candida krusei* (Lockhart et al., 2012).

Candidiasis Rates, 2009–2017



Incidence rates per 100,000 person-years, by age group, 2009–2017. Source: CDC.

The surveillance data by the CDC reports that up to 25% mortality is seen in hospitalized patients with candidemia. Of course, those with candidemia are those who have entered a hospital with chronic diseases, concomitant medical issues, immune deficiency, medical devices, and thus are at greater risk for fungal infections after multiple uses of antibiotics—so the true cause of death is multifactorial.

Environments and People at Risk

When the human body is healthy and body systems work well together, the immune system is able to keep fungus and bacteria in balance and use them as normal flora to help with digestion of food. When a body is out of balance and in a disease or illness state, the immune system has a difficult time taming the normal pathogens that share the human environment. Bacteria or fungi may increase, resulting in infection.

Populations at risk for a normal flora imbalance include women during pregnancy and people with chronic diseases such as diabetes mellitus, HIV/AIDS, and cancer, as well as people taking antirejection medications for organ and tissue transplants, those immunocompromised, and any person with an autoimmune disease (Kwamin et al., 2013). There is also a correlation between GI tracts that are high in yeast and the development of Crohn's disease (Gerard, et al., 2013).

Another example of populations at risk include infants. Oral thrush occurs in up to 6% of babies less than 1 month old and occurs in up to 20% of people who are having chemotherapy or those who have HIV/AIDS. Approximately 75% of women will have at least one yeast infection during their lifetime, and very often after receiving an oral antibiotic for a bacterial infection (CDC, 2019a).

When a person uses a glucocorticoid inhaler, which increases blood sugar levels in the mouth, that mouth becomes an ideal location for yeast, resulting in oral **thrush**. Young babies that consume milk without rinsing of the mouth or bottles that drip during sleep, also increase the risk for oral thrush and dental caries where both yeast and bacteria thrive (Sardi et al., 2013).

The use of antibiotics also increases the risk of developing a candida infection as the antibiotics kill off the **normal flora** of bacteria and allow the yeast to grow unopposed. This is common for women who use antibiotics for a bacterial infection somewhere else in the body and later develop a vaginal yeast infection. Antibiotics disrupt the normal vaginal flora of lactic acid bacteria, such as lactobacilli, and candida can become overgrown. Patients who receive any antibiotic treatment should be taught to consume lactobacillus or acidophilus found in yogurt, or take an over-the-counter probiotic tablet, to replace the normal bacterial flora and combat the potential overgrowth of yeast.

The Emerging Super Bug of *Candida auris*

Candida auris is a type of candida and was first identified in the ear discharge of a hospitalized patient in Japan in 2009 (STAT, 2016). It is responsible for serious hospital-acquired illnesses and has a mortality rate as high as 60%.

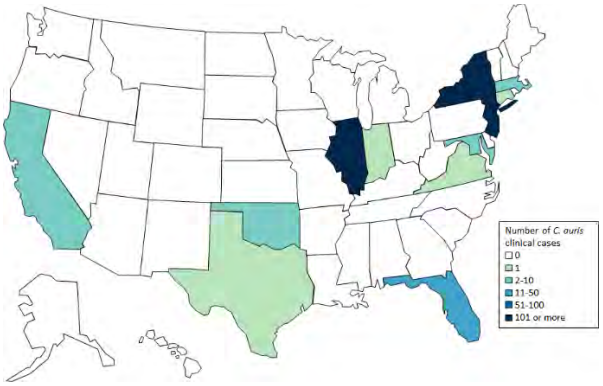
Hospital acquired infections (HAIs) are unfortunately commonly caused by yeast overgrowth, and those with mechanical devices are at an additional risk because the medical devices offer an additional site for yeast to attach to and grow out of control; it **Candidemia** is when the yeast enters and flourishes in the bloodstream of a human host represents the fourth leading cause of bloodstream infection in hospitalized patients in the United States (CDC, 2019c). Symptoms of candidemia are generalized and nonspecific. Usually fever that does not improve after antibiotic treatment is a clue to the etiology's being yeast. If the yeast moves into other body organs—the kidneys, brain, eyes, or esophagus—symptoms become specific to that body system.

Candida auris has become the yeast of most concern now as it has become a resistant fungal infection, especially in hospitals. Species of the general genus candida have been considered as normal flora and have co-existed since birth such as oral thrush and diaper rash. Alarmingly, *Candida auris* is resistant to our usual antifungals (e.g., fluconazole). Those at greatest risk are hospitalized patients with a puncture of some sort: an IV line or a mechanical device such as an arterial line or endotracheal tube.

Ninety percent of *Candida auris* pathogens are resistant to at least one antifungal and 30% are resistant to two or more antifungals commonly used to kill these pathogens in the past, making the once-easy-to-treat fungus deadly. Over 587 patients in California, and more than 300 in New York, have been affected by the deadly yeast (*Today Show*, April 2019). *Candida auris* doesn't seem to appear in healthy people in the community, but rather those immunocompromised in hospital settings and nursing homes. The medical concern is the fear of the organism making that jump from patients at risk to the general community. The Centers for Disease Control and Prevention (CDC) has indicated that the incidence of *Candida auris* is now worldwide, with reported numerous cases in the United States, India, and Africa (CDC, 2019b).

Since 2016 it is reported that 613 people nationwide have died due to inability to treat an infection with *Candida auris* (*ABC New York News*, 2019). Hospitals and facilities often do not want to announce the incidence of cases within their own premises to avoid public hysteria or thwart new patients being admitted. Over half of the reported cases revealed 319 of the deaths have occurred in New York hospitals, where the outbreak appears to continue; of those, 157 patients of have died, representing a very high 57% mortality rate.

C. Auris Clinical Cases by State, as of 2019



Source: Courtesy of Wikimedia Commons. Public domain.

The New York State Department of Health reports that they are "working aggressively with impacted hospitals and nursing homes to implement infection control strategies for *Candida auris* (New York DOH, 2019).

Apply Your Knowledge

What are the different risk factors that a patient in a critical care unit may have that a person in a regular medical unit may not have? How are these patients both at risk once they are in a hospital?

3. Symptoms, Diagnosis, and Management of Candida

Clinical Symptoms

The clinical symptoms vary depending on the location affected by the yeast. From head to toe, the most common sites for fungal infections include the scalp, skin, mouth, gastrointestinal tract, genitourinary tract, vagina, and nail beds of the hands and feet. The most dangerous type of fungal infection is an **invasive infection** (or *systemic infection*) that enters the bloodstream; it is called **candidemia.** Fungal infections that originate in the oral cavity and extend into the esophagus have a higher potential to become an invasive infection because they become systemic.

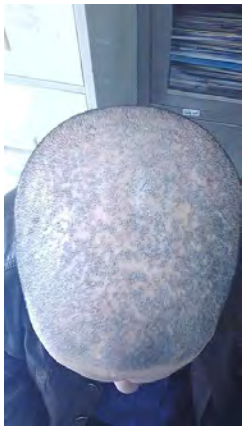
Classically, yeast infections look red, warm, sometimes scaly, and continue to spread if not treated. They can be itchy but not generally painful unless directly on the skin of the genitals and buttocks. They generally do not cause a fever but if not treated can cause a sense of malaise and gastrointestinal upset and bloating if in the GI tract. To review the specific symptoms, let's look at each of them based on locations of the body.

Skin Infections

Topical skin infections include the scalp, head, face, back, chest, axilla, under the breast or in other skin folds, and anywhere on the body from head to toe. When a yeast infection develops on the skin it generally appears red, scaly and inflamed with symptoms of itching and burning, however unique configurations can occur that help diagnose the yeast. An example is the classic shape of a ringworm infection on the skin, called *Tinea corporis*. Ringworm is misnamed because there is no actual worm on the skin, rather the unique shape caused by the **dermatophyte yeast.** Superficial skin infections by yeast at the epidermis are caused by fungi called *dermatophytes*.

The following are images of various types of skin yeast infections.

Intertrigo: Axilla (Armpit)	Intertrigo: Diaper Rash
 A pathogenic bacterial growth in the armpit. Source: Wikimedia Commons. Public domain.	 Diaper rash. Source: Wikimedia Commons. Creative Commons Attribution-Share Alike 3.0 Unported

Tinea Capitis	Tinea Corporis: “Ringworm”
 Tinea capitis. Source: Gholamreza Baqeri. Wikimedia Commons. Creative Commons Attribution-Share Alike 4.0 International.	 Ringworm in the armpit area. ProjectManhattan. Source: Wikimedia Commons. Creative Commons Attribution-Share Alike 3.0 Unported

Tinea Pedis	Tinea Versicolor
 Vesicular Athlete's Foot. Soodleksw. Source: Wikimedia Commons. Public domain.	 Tinea versicolor on the abdomen of a female patient. Sarah Korf. Source: Wikimedia Commons. Creative Commons Attribution-Share Alike 2.0 Generic.

Internal Infections

Because yeast is common as topical normal flora, skin infections can easily develop given the right environment. Additionally, the moist and warm internal environment of the body offers ideal growth for candida.

From head to toe, internal candida infections commonly occur in the mouth, known as oral thrush. It appears as a white sticky coating and can even appear hairy from the extensions of hyphae. It can be easily treated with an oral antifungal, such as a swish and swallow medication. Good oral hygiene for patients on ventilators and rinsing after taking an inhaled glucocorticoid can help prevent this.

Gastrointestinal yeast infections often present as GI bloating, nausea, vomiting, diarrhea and generalized malaise. In diets high in sugar, the GI yeast can easily grow and contribute to belly fat, constipation, poor metabolism of food, and further infection (García-Elorriaga & Rey-Pineda, 2013).

A common internal yeast infection occurs in the vagina. Symptoms include vaginal itching, foul fishy odor, and white cottage-cheese–like discharge. Upon visualization using a speculum, it is easy to diagnose because of its white discharge. It can be cultured for definitive diagnosis however, most clinicians will easily recognize it and treat it with antifungals intravaginally, or orally.

Skin yeast infections can also appear as a red, flat rash with scalloped edges. **Satellite lesions** are extensions of the original yeast that grow to extend the rash. As noted above, tinea infections are identified by their location on the body.

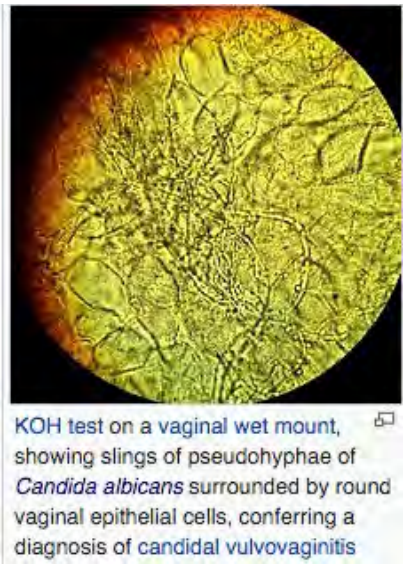
Vaginal Candidiasis


Speculum exam in candidal vulvovaginitis, showing thick, curd-like plaque on the anterior vaginal wall. A slightly erythematous base is visible close to the center of the image, where some of the plaque was scraped off. Mikael Häggström. Source: Wikimedia Commons. Creative Commons CC0 1.0 Universal Public Domain Dedication.

Diagnosing Candida

Often a candida infection is easily identifiable, but a definitive diagnosis can only be done via a microscope or culturing. A skin scraping or swab sampling can be placed under a microscope, which reveals the typical and classic **hyphae** or fern-like growths. A single drop of potassium hydroxide, KOH, is often added to the microscopic slide, which dissolves the human skin cell wall and exposes the yeast and identifiable hyphae.

KOH Test on a Candida Specimen


KOH test on a vaginal wet mount, showing slings of pseudohyphae of *Candida albicans* surrounded by round vaginal epithelial cells, conferring a diagnosis of candidal vulvovaginitis

Mikael Häggström. Source: Wikimedia Commons. Creative Commons CC0 1.0 Universal Public Domain Dedication.

When using the culture method, a simple sterile swab of the infected surface is wiped on the culture medium (e.g., a blood agar petri dish) and allowed to grow in an incubated temperature of 98.6ºF for several days. Yeast and bacterial colonies easily occur within 3 to 5 days. Because candida is part of the normal flora, identifying a true infection is based on the various candida species that may grow in an agar culture, the agar fermentation, and assimilation tests.

Agar Plate Culture of *C. Albicans*

Source: CDC Public Health Image Library. Public domain.

Clinicians can often recognize a yeast infection based on its location and classic morphology and do not order diagnostic tests but treat right away. For example, when a practitioner sees the classic ring worm formation a topical antifungal is ordered. Occasionally a clinician may observe the skin directly with an ultraviolet light known as a **Wood's lamp**. The spores of the yeast become fluorescent with a Wood's lamp and appear blue-green when exposed to ultraviolet light.

For invasive agents within the bloodstream, non-culture candida detection tests can be done with antigen testing such as the Beta-D-Glucan, or candida PCR, which detects candidal DNA. Candida heat-liable-antigen assays—D-arabinitol assay or D-inositol assay—can also be used based on the laboratory's preference and equipment. Immunological tests such as skin tests can also be performed.

Treatment of Yeast

Prompt treatment is key to quick destruction of out of control yeast.
Pharmacological treatment of candida depends on the location. The severity of the fungal infection also dictates the type of antifungal to be used for treatment. An acute fungal infection on the skin can often easily be treated with topical antifungals, however if they have become extensive or chronic, often long-term topical agents in addition to oral agents need to be prescribed.

For most acute fungal skin infections, topical antifungals commonly used include:

- Clotrimazole (Lotrimin, Mycelex)
- Ketoconazole (Xolegel)
- Miconazole (aloe vesta antifungal, azolen, baza antifungal, carrington antifungal, critic aid clear, cruex prescription strength, dermafungal, desenex, fungoid tincture, micaderm, micatin, micro-guard, miranel, mitrazol, podactin, remedy antifungal, secura antifungal)
- Terbinafine (Lamisil)

Prescription topical agents for resistant or extensive infections may include:

- Ciclopirox (Loprox, Penlac)
- Ketoconazole (Nizoral)
- Oxiconazole (Oxistat)

Administration of these antifungals are generally via a cream that is applied twice daily for 2 to 4 weeks. The length of application depends of course on the severity of the yeast and if the infection is acute or chronic. A topical ringworm infection may require treatment for 14 days, however a topical great-toenail fungal infection may require months of treatment and be very difficult to get rid of as the yeast have become embedded in the matrix of the nail. For chronic yeast infections, an oral antifungal should be given and may include (Jaliman, 2019):

- Fluconazole (Diflucan)
- Griseofulvin (Fulvicin P/G, Fulvicin U/F, Grifulvin V, Gris-Peg): oral and spray. May need 8-10 weeks for effect. Cannot take during pregnancy or breastfeeding. May cause birth defects. Men should use condoms for up to six months after treatment to prevent birth defects.
- Itraconazole (Sporanox): 1-2 weeks. Not for use in elderly and children with liver disease.
- Ketoconazole (Nizoral)
- Terbinafine (Lamisil): once daily x 4 weeks

All oral antifungals are processed by the liver's first-pass effect, which may cause nausea, diarrhea, indigestion, headache, dizziness, and even rashes. These oral antifungals are contraindicated for those with liver disease and lupus.

For severe fungal infections that impact a mechanical device, prescription IV antibiotics that are used include:

- Amphotericin
- Azole antifungals
- Echinocandins such as micafungin

Removal of the mechanic device or tube should also be a priority to avoid entry of the pathogen into the bloodstream.

Alternative medicines and folk medicine have been used to treat yeast infections. Although not endorsed by the American Medical Association, patients may be using these remedies and healthcare professionals should be aware of them. Many studies exist demonstrating the effectiveness of various essential oils (e.g., oregano oil) and even food substances (Alves-Silva, 2013). Studies have even shown effectiveness of apple cider vinegar against topical and intestinal yeasts.

4. Prevention Strategies for Yeast Infections

Naturally, avoiding yeast infections is always the best prevention. Disrupting the ideal growth conditions is the goal. Remembering that yeast grow best in warm, moist, sugar-filled reservoirs helps guide prevention strategies to keep tissues dry and free of excess sugar consumption. For athletes who are prone to athlete's foot or *Tinea versicolor* of the trunk, frequent washing after sports with adequate drying of the skin is key. For those who struggle with intestinal bloating, eliminating or decreasing diets high in sugar can help prevent a belly buffet for the yeast.

Prevention strategies include the following ideas for yourself and your patients (Martin, 2012):

Protect your nails

- Don't push cuticles too far back.
- Take your own instruments to a nail salon or confirm they sterilize instruments between clients.
- Clean and dry between toes after bathing.
- Get rid of any shoes/flip flops that you wore if you had athlete's foot.
- Use topical antifungal powders if you're prone to foot fungus.

Protect your skin

- Wash workout clothes, T-shirts, swimsuits, etc. after each workout.
- Wear clothing that may “wick” moisture away from skin (e.g., cotton)
- Bathe daily with a soap cleansing product
- Bathe or wash hands after playing with animals

Protect your gut

- Eliminate or more realistically, decrease sugar intake
- Consume natural fruits and vegetables that contain inherent natural pathogens that balance the gut flora
- Consume a daily probiotic

Protect your mouth

- Perform daily oral hygiene and brushing of teeth and tongue
- Rinse your mouth or brush your teeth after consuming sugary foods
- Don’t allow baby bottles to be propped up for feeding
- Rinse a baby’s mouth after feedings

Hospital Protocols

Because *Candida auris* is generally an issue in hospital and medical facilities and not the general community, hospital cleaning protocols have been established to prevent the spread of candida (Martins, 2014). *Candida auris* is difficult to detect, especially within the blood or internal organs, and hospital settings have increased their environmental cleaning to use antifungal cleansers and UV lights to detect the yeast on hospital furniture and surfaces.

Prompt and frequent handwashing remains the best deterrent for transmitting yeast. Improving patient room cleaning between patients has been a focus of recommendations by the CDC for prevention. Manufacturers are improving anti-yeast cleaning agents, though they are still being developed.

Complementary and Alternative Therapies

In addition to the FDA-approved pharmacologic approaches to treating a yeast infection, there are many folk medicine strategies. Although not endorsed by the FDA, nor are they considered standard practice guidelines, many people are using alternative methods and it's important that heathcare workers and providers are aware of what is being used so they can better educate patients on their efficacy or contraindications for use.
Such folk medicine practices include:

- Bone broth cleanses
- Eliminating starchy foods such as rice, potatoes, wheat, syrups, and sugar
- Consuming 1 to 4 tablespoons of coconut oil daily
- Eating fermented vegetables like bitter greens, kimchi, kefir, kale, or sour kraut that offer organic acid, which lowers colonic pH (e.g., apple cider vinegar, thyme, and oregano, which are turpins that kill yeast).

Using specific essential oils can be very beneficial; orally consuming 2 to 3 drops of oregano essential oil in warm water twice daily for 14 days can be very helpful against yeast. *Topical* oregano essential oil is also powerful, but can burn the surrounding skin, so a carrier oil is needed. One Portuguese study showed that common household herbs such as coriander, bush-basil, and celery could be used as essential oils because of their antimicrobial properties (Alves-Silva, 2013).

Oil pulling is a process of sucking essential oils back and forth through your teeth for 10 to 20 minutes and then spitting them out. Using coconut oil, cloves, garlic, and/or oregano can be very effective against oral thrush.

Colloidal silver (50–150 mcg silver maximum daily) or fermented silver are also being used internally with intriguing claims. Taking a daily probiotic for at least 30 days has been shown to be helpful to create a healthy gut. Another home remedy is using simple baking soda and water for vaginal douching (sodium kills yeast), however it may not be adequate to fight an existing infection.

Another interesting strategy is using yeast to kill yeast. Larger yeast organisms such as mushrooms and soil-based organisms including Saccho boulardi, a Chinese mushroom, can fight the single-cell organism of intestinal yeast.

Warming foods such as meat, lamb, cinnamon, rosemary, cloves, ginger, turmeric, pao darco (a common Chinese herb) and black cumin, are strategies in Traditional Chinese Medicine that dry the body against a moist internal environment, which would make it difficult for yeast to grow. Eliminating processed sugar in the diet is a simple method to starve the yeast and thus inhibit their growth. Some nutritionists suggest eliminating grains from the diet, because they break down into simple sugars that feed yeast.

One way to tell if the yeast is finally destroyed is looking at the tongue. A pink, moist tongue without a white coating is a healthy tongue and a glimpse into the body. Symptoms that point to yeast overgrowth within the body are post meal bloating, whiteness on the tongue, fatigue, pale and irregular stool, and gastric pain, acid reflux, and sluggish metabolism.

Special Case of *Candida auris*

The above treatments are generally focused on the more common candida; however, the treatment for the more threatening *Candida auris* is challenging and serious. Currently the incidence of *Candida auris* is limited to hospital and nursing home settings and has not reached the general healthy population.

Because yeast is highly contagious, it can be transferred easily and transported from person to person. Currently, there have been no reports of *Candida auris* moving from hospital personnel to out-of-hospital family members or community persons. The risk is real, however.

Touching hands after touching someone with the yeast allows for easy transportation of the yeast. Hand washing remains the best practice to break the link between host and transportation to a new host. The alcohol gel sanitizers used in healthcare facilities are effective, and 20–30 second handwashing with soap and water is effective against candida.

Apply Your Knowledge

What counsel do you give a patient who has developed an oral yeast infection? What counsel do you give to a family member or friend who has developed an oral yeast infection? Does your advice change?

5. Summary

Candida is a type of yeast that is part of the normal flora of the human body. An opportunistic infection, it can grow out of control and cause candidiasis. *Candida auris* is a new type of yeast seen recently in hospitals that has recently caused serious outbreaks and a high mortality for patients at risk (including children younger than 1 year, and adults older than 65).

The Centers of Disease Control and Prevention monitor cases of candidiasis and candidemia and have noted trends showing increases in several states as *C. auris* has become drug resistant—causing national alarm. Healthcare professionals need to be aware of the causes, risk factors, prevention, and treatment for the most common types of candida, especially *albicans* and *auris.*

Simple hand-washing and correct use of personal protective equipment and room cleaning are all effective methods to prevent the spread of *C. auris* in our hospitals.

6. References

Alves-Silva JM, dos Santos SMD, Pintado ME, et al. (2013). Chemical composition and in vitro antimicrobial, antifungal, and antioxidant properties of essential oils obtained from some herbs widely used in Portugal. *Food Control.* Elsevier Ltd; 32:3718. http://linkinghub.elsevier.com/retrieve/pii/S0956713513000030.

Centers for Disease Control and Prevention (2019a). *Candida Auris.* Information for Laboratorians and health Professionals. Retrieved July 18, 2019 from https://www.cdc.gov/fungal/candida-auris/health-professionals.html.

Centers for Disease Control and Prevention (2019b). *Invasive Candidiasis Statistics*. Retrieved from https://www.cdc.gov/fungal/diseases/candidiasis/invasive/statistics.html.

Centers for Disease Control and Prevention (2019c). Invasive Candidiasis Statistics. Retrieved from https://www.cdc.gov/fungal/diseases/candidiasis/invasive/statistics.html.

Cleveland AA, Harrison LH, Farley MM, et al. (2015). declining incidence of candidemia and the shifting epidemiology of candida resistance in two US metropolitan areas, 2008–2013: Results from population-based surveillance. PloS One;10:e0120452.

Erdogan A, Rao S. (2015) Small intestinal fungal overgrowth. *Curr Gastroenterol Rep. Mycopathologia* 17(4):16. Retrieved August 28, 2019 from https://link.springer.com/article/10.1007%2Fs11046-014-9749-1.

García-Elorriaga G, Rey-Pineda G. (2013). Nutrition and intestinal microflora. *J Nutr Ther*. 2:112–21.

Gerard R, Sendid B, Colombel JF, et al. (2013). An immunological link between *Candida albicans* colonization and Crohn's disease. *Crit Rev Microbiol.* 2013;1–5.

Huether S, McCance K. (2008). *Understanding Pathophysiology,* 4th ed. Mosby: Elsevier.
Jaliman D. (2019). Understanding Ringworm—Diagnosis and Treatment. WebMD. Retrieved August 28, 2019 from https://www.webmd.com/skin-problems-and-treatments/what-is-the-treatment-for-ringworm.

Kwamin F, Nartey NO, Codjoe FS, Newman MJ. (2013). Distribution of Candida species among HIV-positive patients with oropharyngeal candidiasis in Accra, Ghana. *J Infect Dev Ctries.* 7:041–45.

Lockhart SR, Iqbal N, Cleveland AA, et al. (2012). Species identification and antifungal susceptibility testing of candida bloodstream isolates from population-based surveillance studies in two U.S. cities from 2008 to 2011. *Journal of Clinical Microbiology* 50:3435–42.

Magill SS, O'Leary E, Janelle SJ, et al. (2018). Changes in Prevalence of Health Care-Associated Infections in U.S. Hospitals. Retrieved August 28, 2019 from *New England Journal of Medicine* 2018;379:1732-44.

Martin L. (2012). Ringworm or Candida: What's the Difference? WebMD. Retrieved August 28, 2019 from https://www.webmd.com/skin-problems-and-treatments/features/ringworm-or-candida#3.

Martins N, Ferreira I, Barros L, et al. (2014, June). Candidiasis: Predisposing factors, prevention, diagnosis, and alternative treatment." *Mycopathologia*. 177(5–6):223–240. Department of Surgical Education—Orlando Regional Medical Center. Management of Candida infections in surgical patients. Orlando–Florida, USA. 2002. pp. 1–10. Retrieved from

https://link.springer.com/article/10.1007%2Fs11046-014-9749-1.

McCoombs J. (n.d.). An Introduction to History of Candida. Candida Library. Retrieved August 28, 2019 from http://www.candidalibrary.org/cand_lib/article.php?id=075.

Newman T. (2019). How Do Penicillins Work? *Medical News Today*. Retrieved August 28, 2019 from https://www.medicalnewstoday.com/articles/216798.php.

Sardi JCO, Scorzoni L, Bernardi T, et al. (2013). Candida species: Current epidemiology, pathogenicity, biofilm formation, natural antifungal products, and new therapeutic options. J Med Microbiology 62:10–24. Retrieved August 28, 2019 from http://www.ncbi.nlm.nih.gov/pubmed/23180477.

STAT. (2016). Deadly strain of yeast infection pops up in hospitals around the world. Retrieved August 2. 2019 from https://www.statnews.com/2016/06/29/yeast-infection-hospitals-candida/.

Vázquez-González D, Perusquía-Ortiz AM, ET AL. (2013). Opportunistic yeast infections: Candidiasis, cryptococcosis, trichosporonosis, and geotrichosis. *J Ger Soc Dermatol.* 2013;11:381–94. http://www.ncbi.nlm.nih.gov/pubmed/23621330.

Zhang A, Shrum S, Williams S, et al. (2018). The Changing Epidemiology of Candidemia in the United States: Injection Drug Use as an Emerging Risk Factor for Candidemia. ID Week. San Francisco, CA 2018.

Post Test

1. Which of the following is a characteristic of yeast?

    a. Ability to grow anaerobically.
    b. Ovoid cells that can extend into tissues with hyphae.
    c. Cells that exist without natural competition.
    d. Ability to exist by eating only protein.

2. Which of the following is **not** a type of candida infection?

    a. Vaginal yeast infection
    b. *Tinea capitus*
    c. *Tinea versicolor*
    d. Exzema

3. Which type of a candida infection appears on the feet, known as athlete's foot?

    a. *Candida barbis*
    b. *Candida corporis*
    c. *Candida pedis*
    d. *Candida manus*

4. What is the current incidence of candida infections nationwide?

    a. 4% of the total population
    b. 9 out of 100,000 people the United States.
    c. As high as the incidence of diabetes mellitus in the United States population
    d. 25% of hospitalized patients

5. What is the species of Candida that is emerging as drug-resistant?

    a. *Candida albicans*
    b. *Candida auris*
    c. *Candida acumulata*
    d. *Candida penicillium*

6. What of the following is **not** a risk factors to developing a candida overgrowth?

    a. Immunocompromised
    b. Use of antibiotics
    c. Indwelling mechanical devices such as catheters and ET tubes
    d. High protein diet

7. What is the definitive method of diagnosing a yeast infection? (b)

    a. Visualization with the naked eye
    b. Culture and sensitivity of skin and tissue sample
    c. Wood's lamp
    d. Symptoms only

8. Which **one** of the statements is true?

    a. A yeast infection will always present with a fever.
    b. A yeast infection will never present with a fever.
    c. Symptoms of a yeast infection vary based on the location of the infection.
    d. All yeast infections present with the same clinical appearance.

9. What is the best treatment for a vaginal yeast infection?

a. Either a topical or vaginal antifungal
b. IV antibiotics only
c. Only a topical antifungal
d. Neither, it is impossible to treat

10. What class of medications is best for treatment of fungal infections?

a. Penicillins
b. Cephalosporins
c. “azole” medications
d. Steroids

11. Which **one** of the statements is true about hospital protocols to prevent yeast infections within the hospital.

a. Handwashing with gels is sufficient against candida.
b. Using PPEs and washing hands in between patients is key.
c. Housekeepers should be using ultraviolet lights on every room.
d. Antibacterial gels are adequate for hand washing between patients who have candida infections.

12. What is the standard when using a complementary or alternative therapy to treat or prevent a yeast infection?

a. All home remedies are safe to use.
b. Home and folk medicine may work but should be used with caution.
c. No home remedies or folk medicine should ever be used.
d. Only the doctor can prescribe the use of essential oils.

Answer Sheet

Name (Please print) _____

Date_____

Passing score is 80%

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____

Course Evaluation: Candida

Please use this scale for your course evaluation. Items with asterisks * are required.

5 = Strongly agree 4 = Agree 3 = Neutral 2 = Disagree 1 = Strongly disagree

*Upon completion of the course, I was able to:

1. List at least 6 variations of candida in the human population. 5 4 3 2 1
2. Describe the incidence and prevalence of candida yeast infections. 5 4 3 2 1
3. State the 2 populations wherein *C. auris* has been identified. 5 4 3 2 1
4. Identify 2 ways of diagnosing yeast infections. 5 4 3 2 1

*The author(s) are knowledgeable about the subject matter. 5 4 3 2 1

*The author(s) cited evidence that supported the material presented. 5 4 3 2 1

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