Clinical & Diagnostic Microbiology

GI, Skin, Soft Tissue & Wound

Skin/Soft Tissue (Wound) Infections - I

Skin Description and Functions

- The body's first line of defense against microbial invasion
- A dynamic physical barrier
- Undergoes continual epithelial cell turnover
- Removes substances as well as potentially pathogenic microorganisms on its surface
- Colonized with a variety of resident microbes that perform a protective function

What's Ahead?

- The role of indigenous skin biota and other organisms in the pathogenesis of skin infection
- The clinical features and causes of systemic infections
- The dermatologic manifestations of systemic infections
- The diagnosis and treatment of specific skin and soft tissue infections

Clinical & Diagnostic Microbiology

Skin/Soft Tissue (Wound) Infections

Anatomy of the Skin

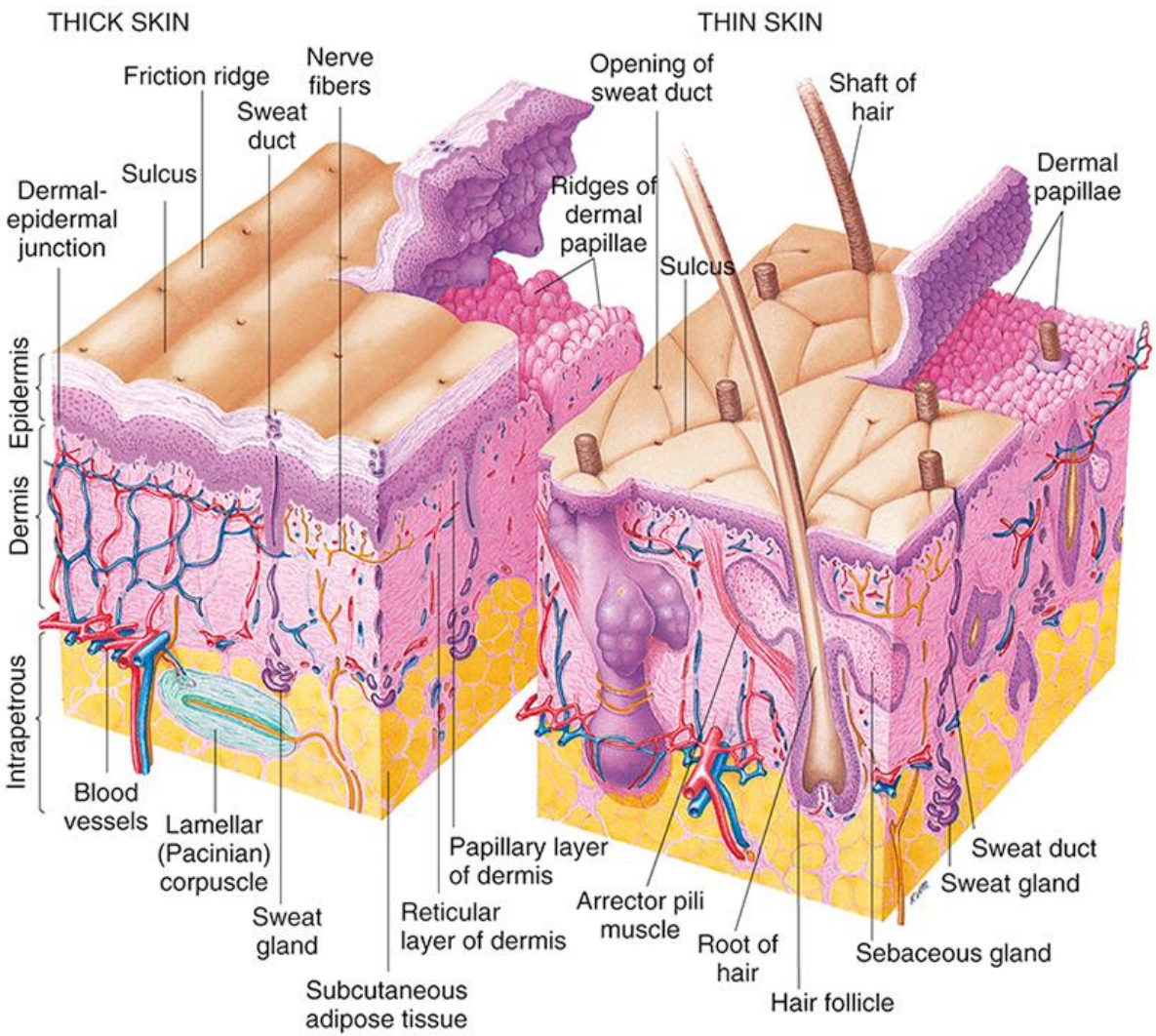
Anatomy of the Skin

- Epidermis
  - Outer most layer (stratum corneum) is composed of several layers of epithelial cells
    - Contains dead cells consisting of a protein called keratin
- Dermis
  - Second skin layer
    - Thick layer composed of connective tissue
    - Contains sweat gland ducts, hair follicles, and oil gland ducts

Anatomy of the Skin (Cont.)

- Sebum and perspiration provide moisture and nutrients necessary for the growth of certain microbes.
- The salt and lysozymes contained in perspiration and fatty acids found in the sebum can inhibit the proliferation of pathogenic microorganisms.

Anatomy of the Skin



From Patton KT, Thibodeau GA: *Anatomy and physiology*, ed 7, St Louis, 2010, Mosby.

Skin Microbiota

- The usual biota of the skin adapt to high salt, exposure to the elements and relative lack of nutrients.
- Normal residents of skin biota
  - An array of bacteria, fungi, and viruses
  - These microbes may act as competitive inhibitors of pathogenic organisms.
- Breaks in the skin allow normal biota to cause infection and transient organisms to enter and cause disease.

Skin Biota (Cont.)

- Typical resident members of skin biota
  - Gram-positive cocci
    - *Staphylococcus epidermidis*
    - Streptococci
  - Gram-positive bacilli
    - *Cutibacterium acnes*
    - *Corynebacterium*
  - Fungi
    - *Candida* and *Malassezia*
- *Staphylococcus aureus*
  - Transient colonizer

Skin Biota (Cont.)

- Resident microbiota colonization is not eliminated during vigorous washing.
- The acidic pH of skin (~5.0) inhibits many common skin pathogens.

Clinical & Diagnostic Microbiology

Skin/Soft Tissue (Wound) Infections
Localized Bacterial & Fungal Infections

Introduction

- Bacteria are the cause of most skin infections.
  - Antimicrobial resistance has made them more difficult to treat.
    - *Staphylococcus aureus* is one of the most common.
    - Other bacteria that display multidrug resistance include *Pseudomonas aeruginosa*, *Enterococcus*, beta-hemolytic *Streptococcus*, *Escherichia coli*, and *Enterobacter* spp.

Some Infectious Causes of Skin Lesions and their Morphologic Manifestations

BOX 33.1 Some Infectious Causes of Skin Lesions and Their Morphologic Manifestations

Macular, Papular, or Maculopapular Rashes
Rubeola (measles)
Rubella (German measles)
Roseola
Other viral exanthems
Scarlet fever
Toxic shock syndrome
Secondary syphilis

Smooth Papules
Molluscum contagiosum
Condyloma latum (secondary syphilis)

Verrucous Papules or Plaques
Condyloma acuminata (anogenital warts)
Nongenital cutaneous warts
Cutaneous tuberculosis
Blastomycosis
Coccidioidomycosis
Chromomycosis

Wheals
Urticaria
Scabies
Cercarial dermatitis (swimmer's itch)
Pruritic papules
Scabies
Folliculitis
Erythema infectiosum (fifth disease)
Bacterial cellulitis
Necrotizing (gangrenous) cellulitis, fasciitis, myonecrosis
Disseminated mycoses

Serpiginous or Annular Plaques
Erythema multiforme
Erythema migrans (Lyme borreliosis)
Cutaneous larval migrans (creeping eruption)

Vesicles or Bullae
Herpes simplex
Herpes zoster
Varicella (chickenpox)
Hand-foot-mouth disease
Herpangina
Staphylococcus scalded-skin syndrome

Pustules
Folliculitis
Impetigo
Acne
Disseminated gonococcal infection
Furuncles, carbuncles
Kerion
Herpetic whitlow
Ecthyma contagiosum (orf)
Milker's nodule
Hidradenitis suppurativa

Continued

Some Infectious Causes of Skin Lesions and their Morphologic Manifestations (Cont.)

BOX 33.1 Some Infectious Causes of Skin Lesions and Their Morphologic Manifestations—cont'd

Petechiae, Purpura, and Ecchymoses

Rocky Mountain spotted fever
Other rickettsial infections
Meningococcemia
Gonococcemia
Infective endocarditis
Plague
Dengue and other hemorrhagic fever viruses
Enteroviral infections
Leptospirosis

Ulcers or Necrosis

Primary syphilis
Herpes simplex
Chancroid
Lymphogranuloma venereum
Granuloma inguinale
Impetigo
Ecthyma gangrenosum
Sporotrichosis
Nontuberculous mycobacteria
Nocardiosis
Histoplasmosis
Anthrax
Ecthyma contagiosum (orf)
Tularemia
Leishmaniasis

Order of Bacteria Causing Skin and Soft Tissue Infections in North America 1998 to 2004

TABLE 33.1 Order of Bacteria Causing Skin and Soft Tissue Infections in North America, 1998 to 2004

Rank	Pathogen	No. of Isolates (% of total)
1	*Staphylococcus aureus*	2602 (44.6)
2	*Pseudomonas aeruginosa*	648 (11.1)
3	*Enterococcus* spp.	542 (9.3)
4	*Escherichia coli*	422 (7.2)
5	*Enterobacter* spp.	282 (4.8)
6	*Klebsiella* spp.	248 (4.2)
7	β-Hemolytic streptococci	237 (4.1)
8	*Proteus mirabilis*	166 (2.8)
9	Coagulase-negative staphylococci	161 (2.8)
10	*Serratia* spp.	125 (2.1)

From Moet GJ, et al: Contemporary causes of skin and soft tissue infections in North America, Latin America, and Europe: report from the SENTRY Antimicrobial Surveillance Program (1998-2004), *Diagn Microbiol Infect Dis* 57:7, 2007.

Classification of Skin and Soft Tissue Infections

- There are multiple classification methods.
  - Appearance of the skin lesion, which provides an important clue about possible causative organisms
  - How the infections manifest themselves
    - Systemic disease
    - Primary skin process
      - May be further categorized by structure affected and further subdivided by causative organism (bacteria, viral, mycobacterial, fungal, parasitic)

Infections Secondary to Preexisting Skin Lesions

TABLE 33.2 Infections Secondary to Preexisting Skin Lesions

Infection	Major Pathogen
Surgical Wound Infection	
Clean	*Staphylococcus aureus*, gram-negative bacilli
Contaminated, such as colon	Plus Enterobacteriaceae, anaerobes, streptococci
Intravenous infusion sites	*S. aureus*, coagulase-negative staphylococci
Trauma	
Soil contamination	*Pseudomonas aeruginosa, Clostridium* spp.
Freshwater contamination	*Aeromonas, Plesiomonas, Mycobacterium marinum*
Saltwater contamination	*Vibrio vulnificus, M. marinum*
Intravenous drug use	*S. aureus, Pseudomonas* spp., *Clostridium* spp.
Bites	
Human	Oral aerobes and anaerobes, *S. aureus*
Dog, cat	*Pasteurella multocida, S. aureus, Capnocytophaga canimorsus,* anaerobes
Rat	*Streptobacillus moniliformis, Spirillum minus*
Other	
Decubitus ulcer	Streptococci, *S. aureus*, coliforms, *Pseudomonas* spp., anaerobes, including *Bacteroides fragilis*
Foot ulcer in diabetic patients	*S. aureus*, streptococci, coliforms, *P. aeruginosa*, anaerobes
Hidradenitis suppurativa	*S. aureus*, streptococci, coliforms, *Pseudomonas* spp., anaerobes
Burns	*S. aureus, Candida, P. aeruginosa*

Organization of this Discussion

- Examination of clinically important and prevalent infections of skin and soft tissues that typically occur in localized areas of the body
  - Presented in order from most superficial infection to the deeper, more serious infections
  - Primarily bacterial and fungal in nature
  - Skin manifestations of systemic infections
    - Bacteria, fungi, viruses, parasites
    - Immune- or toxin-mediated dermatologic diseases triggered by pathogens

Dermatitis

- A general term that describes an inflammation of the skin
- Characterized by areas of redness, swelling, and sometimes scaling of the skin and pruritus
- Many causes, only some of which are related to infection

Intertrigo and Superficial Candidiasis

- Intertrigo
  - Inflammatory cutaneous condition that occurs in body areas subjected to heat, moisture, and friction, which work together to cause maceration and skin breakdown
    - E.g., diaper rash due to *Candida albicans*
  - Occurs in the skin folds, typically the axillae, perineum, beneath the breasts, and in abdominal folds
  - Risk factors: obesity, incontinence, diabetes, compromised immunity, extremes of age

Thrush and Erythrasma

- Thrush
  - Candidiasis involving the oral mucosa; characterized by white, curdlike patches on the tongue, palate, or buccal mucosa
    - Vaginitis is similar in the vulvovaginal area.
    - Balanitis–an inflammation of the glans penis that can spread to the thighs, scrotum, and buttocks

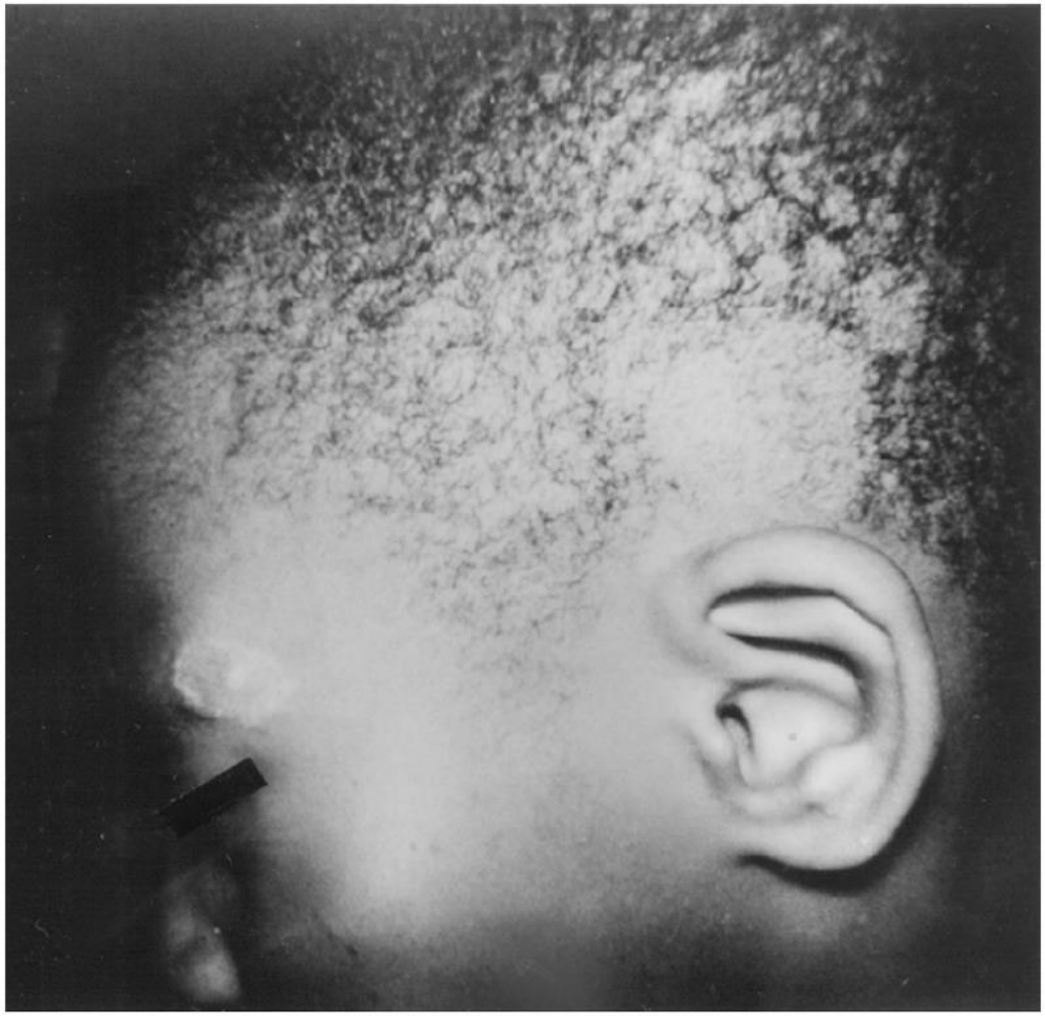
Erythrasma

- A superficial, chronic skin infection that manifests as pruritic reddish-brown macules that are lightly scaled and wrinkled
  - Groin, inner thighs, tow webs
  - Occurs more often in men, obese individuals, patients with diabetes
  - Causative agent: *Corynebacterium minutissimum*
    - Normal skin resident

Dermatophytoses

- Fungi that colonize only keratinized surfaces of the body including hair, nails, and skin
  - *Epidermophyton*, *Trichophyton*, *Microsporum*, and *Nannizzia*
    - Commonly called ringworm or tinea, followed by site
      - Tinea pedis—athlete's foot
      - Tinea cruris—jock itch
      - Tinea capitis—scalp
      - *Tinea corporis*– body in general, often in trunk and legs
      - Tinea versicolor-caused by normal skin commensals

Tinea Capitis



Tinea Corporis

Tinea Versicolor
Hypopigmented (L), Hyperpigmented (R)

Pyrodermas

- Primary pyodermas
  - A group of inflammatory skin disorders caused by bacteria that produce pus
- *Impetigo* is often used interchangeably with *pyoderma*.
  - Note: There are other forms of pyoderma.

Common Primary Pyodermas

TABLE 33.3 Common Primary Pyodermas

Infection	Organism	Comments
Impetigo	*Staphylococcus aureus, Streptococcus pyogenes*	Children affected most; communicable; no fever
Erysipelas	*S. pyogenes;* occasionally other β-hemolytic streptococci or *S. aureus*	Distinct raised borders; fever common
Cellulitis	*S. pyogenes, S. aureus; Haemophilus influenzae* in children	Erythema, tenderness, pain, edema, warmth; fever common
Folliculitis	*S. aureus;* gram-negative bacilli or *Candida* if predisposing conditions	Papules around hair follicles; areas exposed to whirlpool bath (*Pseudomonas aeruginosa*)
Furuncle	*S. aureus*	Fluctuant, painful nodules often in intertriginous areas
Carbuncle	*S. aureus*	Multiple abscesses
Paronychia	*S. aureus,* gram-negative bacilli, *Candida*	Periungual swelling

Impetigo

- Causes
  - Group A streptococci (GASs)
  - *Staphylococcus aureus* (including MRSA)
- Symptoms
  - Small vesicles that become pustules that rupture
  - Discharge is thick and yellow and dries to form a classic golden crust.
    - Superficial, painless, but pruritic
- Bullous impetigo
  - Caused by strains of *S. aureus* that produce exfoliative toxins

Bullous Impetigo Caused By *Staphylococcus aureus*

Erysipelas

- Superficial cellulitis that involves the epidermis, dermis, and lymphatic channels
  - Painful, indurated areas of inflammation with raised borders that are sharply demarcated from adjacent normal skin
    - Bright red to crimson hue with fever
- Most cases caused by GAS
- Other causes, other β-streptococci and *Staphylococcus aureus*

Erysipelas caused by *Staphylococcus aureus*

Erysipeloid

- Superficial soft tissue infection caused by *Erysipelothrix rhusiopathiae*
  - Usually through traumatic break in the skin
- Occupational hazard of handlers of animals, meat, poultry, hides, and saltwater fish
- Fingers and dorsum of hand are most frequent sites of infection.
- Mimics erysipelas
  - Possible complications–septic arthritis, bacteremia

Anthrax

- Causative agent
  - *Bacillus anthracis*
    - Acute febrile illness that causes skin lesions
- Types of anthrax
  - Cutaneous–ulcerative disease
  - Pulmonary or systemic infections
- Skin lesions
  - Face, neck, arms, sites of minor abrasions
  - Painless and evolve causing possible regional lymphadenopathy and bacteremia with fever and hypotension

Anthrax (Cont.)

- Caused by *Bacillus anthracis*, a gram-positive rod that can cause ulcerative skin lesions called eschars
- Associated with people working with animal products that are contaminated with *Bacillus anthracis* spores
- Skin lesions often seen on the face, neck, arms

Cellulitis

- Diffuse inflammation and infection of
  - Superficial skin layers
  - Subcutaneous tissue
- Extends deeper in the soft tissues than erysipelas
  - Appears as painful erythema, warmth, edema of the skin with poorly defined margins
  - Drainage of pus may occur (purulent cellulitis)
- Usually caused by *S. aureus,* GAS (group A streptococci)

Cellulitis (Cont.)

- Possible symptoms
  - May or may not be accompanied by fever or other symptoms of systemic infection
    - Malaise, rigors, headache, elevated WBC count
- Predisposing factors
  - Surgery
  - Other trauma
  - Underlying skin disorders
    - E.g., ulcers or dermatitis

Cellulitis (Cont.)

- Blood cultures are usually negative
- Diagnosis is often made clinically based on the appearance of the affected area.
- Needle aspirations may be done on select patients.
  - Immunocompromised
  - Individuals who do no respond to empiric antimicrobial therapies

Recurrent Cellulitis

- Risk factors
  - Obesity, venous status, untreated tinea pedis
- Mode of entry
  - Breaks in the skin
- Patients with frequent recurrent cellulitis may be treated with long-term suppressive antimicrobial regimens to decrease infection rate.

MRSA Infections and Paronychia

- MRSA infections
  - Community acquired
  - Hospital acquired
- Paronychia
  - Infection of the cuticle surrounding the nail bed
    - Usually through minor skin wound
    - Removing a hangnail
      - Nail margin becomes painful, red, warm, and swollen, and pus may be expressed.

Folliculitis

- Folliculitis
  - Inflammation and infection of hair follicles
    - *S. aureus*, *Pseudomonas aeruginosa*
    - In immunocompromised hosts—*Candida, Malassezia,* or gram-negative bacteria
  - Lesions appear small, erythematous papules may be pruritic, and they often evolve to form pustules with a whitish or yellowish central zone

Furuncles

- Furuncles
  - Occurs when folliculitis progresses to form deeper inflammatory nodules.
  - Prefers warm, moist areas of the body and areas subject to friction
  - Initially red and firm but soon become painful and fluctuant and generally drain spontaneously
  - Most common pathogen: *S. aureus*

Staphylococcus aureus
Furuncle of the Breast

Carbuncles

- Carbuncles
  - Serious lesion that extends into the subcutaneous fat and consists of multiple coalescing abscesses that can drain at several adjacent sites along hair follicles
  - Commonly occur at the nape of the neck and back of the thighs
  - Symptoms–fever and other symptomatic symptoms
  - Complication–bacteremia
  - Causative agent–*S. aureus* -MRSA

Hidradenitis Suppurativa

- Hidradenitis suppurativa
  - Difficult-to-treat recurrent infection of the apocrine sweat glands
    - Nodular, tender, erythematous swellings that become fluctuant and drain
    - Often associated with fever and tender lymphadenitis, can also cause scarring

Bite Infections

- May be from humans or animals
  - Often quite severe and polymicrobial
- Examples of common aerobic and anaerobic pathogens
  - *S. aureus, Streptococcus anginosis, Eikenella corrodens, Fusobacterium nucleatum, Prevotella melaninogenica*

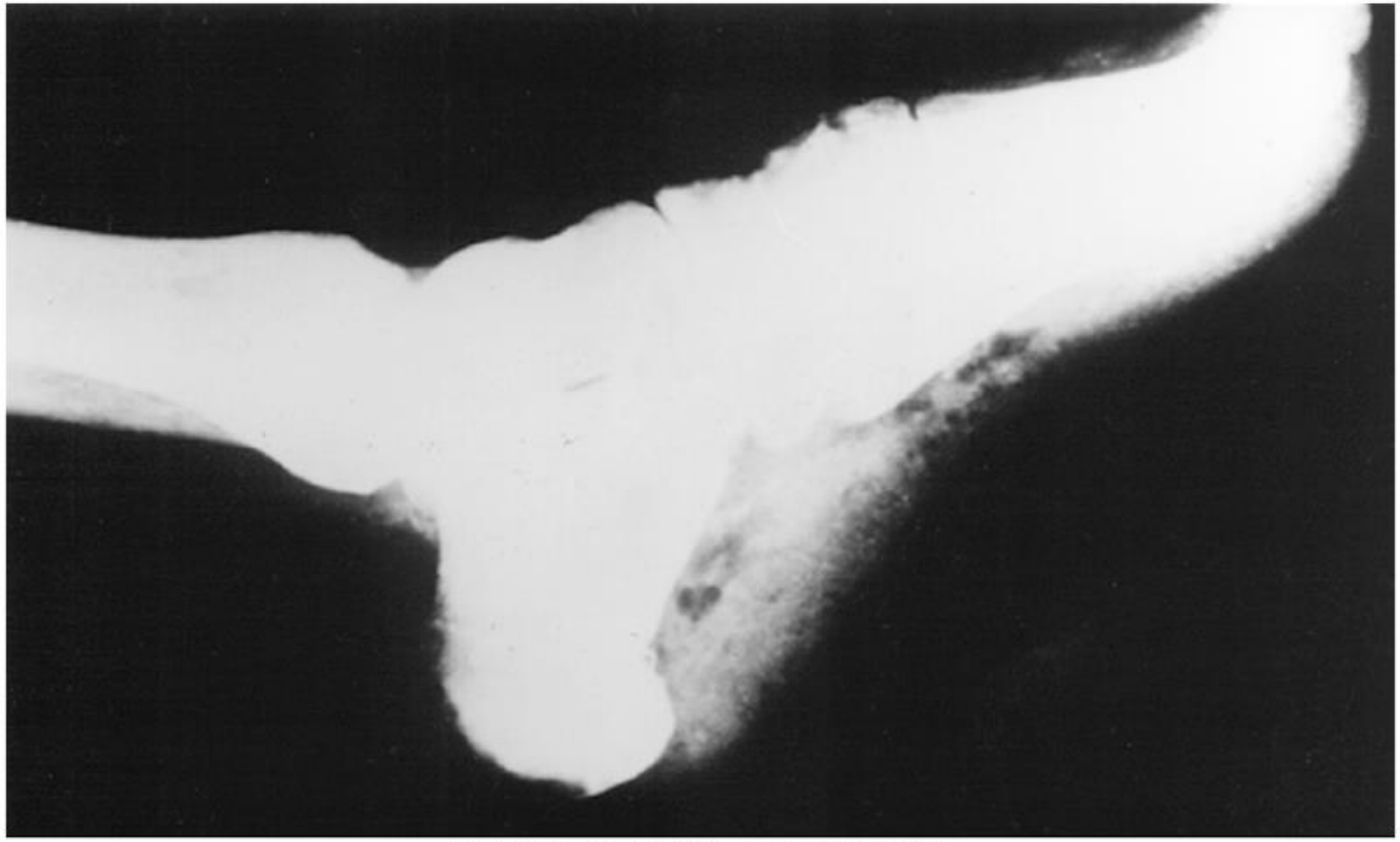
Diabetic Foot Infection Risk Factors

- Peripheral neuropathy
- Trauma to the feet
- Inadequate blood sugar control
- Compromised peripheral vascular circulation caused by diabetes
- Impairment of kidney function
- Improper foot care
  - Walking barefoot
  - Ill-fitting shoes

Diabetic Foot Infection Manifestations

- Cellulitis
  - Typically caused by staphylococci or streptococci
- Acute or chronic soft tissue ulceration
  - With or without underlying bone infection
- Gas gangrene
  - May be caused by staphylococci or streptococci, or mixed infections of other bacteria such as Enterobacterales, *Pseudomonas,* gram-positive bacilli, and anaerobes (notably Clostridium perfringens).

Diabetic Foot Infection with Soft Tissue Gas Formation



Necrotizing Soft Tissue Infection

- Infections that produce tissue necrosis and soft tissue gas can be life-threatening.
- Categories based on level of tissue involvement
  - Superficial, epidermal or dermal structures
  - Fascia
  - Muscle
- Subtypes of infections (infectious gas gangrene)
  - Polymicrobial fasciitis
    - Enterobacterales and anaerobes

Necrotizing Soft Tissue Infection (Cont.)

- Subtypes of infections (infectious gas gangrene)
  - Monomicrobial fasciitis
    - *S. pyogenes*
    - Type II less common–*S. aureus,* younger, previously healthy individuals, infections often involve the extremities
  - Gas gangrene (type III, a.k.a. clostridial myonecrosis)
    - *Clostridium* spp., especially *Clostridium perfringens*
- Other possible causative agents
  - *Vibrio vulnificus, Aeromonas hydrophila*

Clostridial Myonecrosis (Gas Gangrene)

From Finegold SM, George WL, Mulligan ME: *Anaerobic infections*, Kalamazoo, MI, 1986, Upjohn.

Mycetoma

- Madura foot or maduromycosis
  - Chronic skin/subcutaneous infection caused by bacteria or fungi
  - Known as eumycetoma or true fungal infection
  - Causes
    - *Madurella* spp., *Aspergillus* spp. or *Pseudallescheria boydii*, *Nocardia* spp., or *Actinomadura* spp.

Mycetoma (Cont.)

- Symptoms
  - Swelling and suppuration of subcutaneous tissues and formation of sinus tracts, with visible granules formed by aggregates of organisms in the pus draining from these fistulae
  - Slowly progressive and destructive with extension to muscle and bone
- Diagnosis
  - Based on clinical appearance, microscopic examination, culture

Madura Foot

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Major Causative Agents of Subcutaneous Mycoses

TABLE 33.4 Major Causative Agents of Subcutaneous Mycoses

Disease	Principal Organism(s)
Mycetoma	*Madurella mycetomatis, Madurella grisea, Scedosporium apiospermum, Leptosphaeria senegalensis, Exophiala jeanselmei, Pyrenochaeta romeroi, Fusarium* spp., *Acremonium* spp., *Pseudallescheria boydii, Aspergillus nidulans, Neotestudina rosatii, Actinomadura madurae, Actinomadura pelletieri, Nocardia brasiliensis, Nocardia farcinica, Nocardia otitidiscaviarum, Streptomyces somaliensis*
Chromomycosis	*Phialophora verrucosa, Fonsecaea pedrosoi, Fonsecaea compacta, Cladophialophora carrionii, Rhinocladiella aquaspersa*
Phaeohyphomycosis	Dematiaceous fungi (e.g., *Phialophora, Wangiella, Exophiala, Alternaria, Cladosporium*)
Sporotrichosis	*Sporothrix schenckii*
Rhinosporidiosis	*Rhinosporidium seeberi*
Rhinoentomophthoromycosis	*Conidiobolus, Basidiobolus*
Lobo disease	*Lacazia loboi (Loboa loboi)*

Chromoblastomycosis (a.k.a. Chromomycosis)

- Chronic spreading mycosis of the skin and subcutaneous tissues
  - Tropical and subtropical regions of the world
  - Symptoms
    - Localized, scaly lesions, usually of a lower extremity from minor trauma
    - Progression is slow (years) with eventual large warty or cauliflower-like masses and obstruction of lymphatic drainage, leading to swelling

Chromoblastomycosis (a.k.a. Chromomycosis)

- Chronic spreading mycosis of the skin and subcutaneous tissues
  - Causative fungi include: *Fonsecaea pedrosoi, Fonsecaea compacta, Phialophora verrucosa, Cladophialophora carrionii*, and *Rhinocladiella aquaspersa*

Chromomycosis of the Leg

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Phaeohyphomycosis

- Infections caused by fungi that produce dark cell walls
- Also known as dematiaceous fungi
  - Referring to brown or black pigmentation
- Subcutaneous nodules of skin lesions
  - Deeper infections-brain abscess, septic pneumonia, sinusitis
  - *Bipolaris, Exophiala, Phialophora*, and *Curvularia*
    - Found in soil and decaying organic material
    - Found on plants

Mucormycosis

- Disease resulting from members of the order Mucorales
  - Most common pathogens
    - *Rhizopus*, followed by *Mucor* ~~spp.~~, *Rhizomucor, Cunninghamella, Apophysomyces, Lichtheimia*
- Manifests as a localized cutaneous infection via skin inoculation, sometimes by dissemination by another source (i.e., lung, sinuses, brain or GI tract)

Other Uncommon Fungi Entomophthoromycosis

- Members of this fungal order may cause a subcutaneous form of infection
  - Results from traumatic implantation of the organisms in the skin
    - *Conidiobolus coronatus*, *Conidiobolus incongruous*, and *Basidiobolus ranarum*
- Diagnosis
  - Clinically based on the typical skin and soft tissue findings, with confirmation via biopsy

Rhinosporidiosis

- Chronic, usually painless infection of humans and animals that occurs as mucosal polyps of the nasopharynx and conjunctiva
- Causative agent is *Rhinosporidium seeberi*.
  - Organism has never been cultured.
  - Nucleic acid analysis has shown that this organism is a protist that is related to other protist parasites.
- Found in freshwater

Lobomycosis

- Chronic fungal infection of the skin caused by *Lacazia loboi*
  - Manifest as slowly forming skin nodules of various sizes
  - Organism has never been isolated in culture.
- Reside in soil, vegetation, or water and infect humans via skin trauma
- Have been known to infect farmers, hunters, and jungle workers

Nodular Lymphangitis Characteristics

- Also known as lymphocutaneous syndrome
- Inflammatory nodules that occur along lymphatic vessels that drain an area of primary skin infection
- Organisms associated with nodular lymphangitis include
  - *Sporothrix schenckii, Nocardia*, and mycobacteria.

Nodular Lymphangitis Caused by Sporotrichosis with Ulceration

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Agents of Nodular Lymphangitis

BOX 33.2 Microbiological Causes of Lymphocutaneous Syndromes

Fungi
Sporothrix schenckii
Blastomyces dermatitidis
Histoplasma capsulatum
Coccidioides immitis
Scopulariopsis spp.

Actinomycetes
Nocardia spp.

Parasites
Leishmania spp.

Mycobacteria
Mycobacterium marinum
Mycobacterium kansasii
Mycobacterium chelonae
Mycobacterium abscessus
Mycobacterium fortuitum

Bacteria
Staphylococcus aureus
Francisella tularensis
Bacillus anthracis

Viruses
Herpes simplex virus

Sporotrichosis

- Causative agents
  - *Sporothrix schenckii* complex–*S. schenckii, S.brasiliensis, S. globose, S. Mexicana,* and *S. luriei*
- Most frequently recognized cause of nodular lymphangitis through inoculation of the skin
  - Dimorphic fungus
  - Classically an occupational disease of gardeners, farmers, and horticulturalists

Sporotrichosis (Cont.)

- Usually localized to skin and subcutaneous tissue
- Dissemination to bone, lungs, brain, and other organs can occur in immunocompromised person.
- Pulmonary disease can occur via inhaling *S. schenckii* complex conidia are inhaled.

Nocardiosis

- Causative agent—*Nocardia* spp.
- Ubiquitous in the environment and may be found in soil, water, and vegetation
- Mode of transmission
  - Direct cutaneous inoculation
- Manifestation ranges from lymphocutaneous syndrome to subcutaneous abscesses, cellulitis, and mycetoma.

Mycobacterial Infection Nontuberculosus Mycobacteria (NTM)

- Causes cutaneous disease including nodular lymphangitis
- Transmission occurs via
  - Puncture wounds, motor vehicle accidents, injections, and surgery
- Skin infections may result from the hematogenous spread of infection.

Mycobacterial Infection (Cont.)

- *M. marinum*
  - Swimming pool or fish tank granuloma
    - Enters through wound or traumatic break in the skin
  - Solitary red-purple lesions appear 2 to 3 weeks post exposure.
    - Arms and legs
  - Papular or nodular–can become wartlike or ulcerated
  - Infection can progress to lymphcutaneous syndrome.
  - Diagnosis–biopsy and culture of skin lesion and patient history

Mycobacterial Infection (Cont.)

- *M. chelonae*
  - Usually seen in immunocompromised patients
- *M. fortuitum*
  - Usually occurs in otherwise healthy persons
- *M. abscessus* complex
  - Seen in immunocompromised and otherwise healthy presons
- Modes of transmission include
  - Acupuncture, nail salons, tattooing

Mycobacterial Infection (Cont.)

- *M. ulcerans*
  - Associated with swamps
  - Single, pruritic ulcer with undermined edges
    - Called a Buruli ulcer
  - May be chronic infection with limb deformity in tropic climates
  - Slow grower in culture–can take up to 12 weeks of incubation

Mycobacterial Infection (Cont.)

- *M. tuberculosis*
- Cutaneous tuberculosis
  - Uncommon
- Inoculation of the skin can lead to tuberculosis verrucosa cutis (TVC)
  - Red or purple papules that become wartlike
- Occur in areas of the body prone to trauma

Actinomycosis

- *Actinomyces* spp.
  - Chronic disease characterized by the formation of abscesses, fibrosis of tissues, and draining sinuses that discharge sulfur granules (masses of organisms)
  - Primary cause is *A. israelii*.
  - Part of normal biota in the mouth and GI and genital tracts
  - Most common manifestation
    - Involvement with the face and neck

Actinomycosis of the Jaw Following Dental Infection

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Clinical & Diagnostic Microbiology

Skin/Soft Tissue (Wound) Infections
Dermatological Manifestations of Systemic Bacteria & Fungal Infections

Overview

- Systemic infections can produce skin lesions that may provide diagnostic clues
  - Bacterial, fungal, parasitic, viral

Bacteria

- *Pseudomonas* infection
  - Ecthyma gangrenosum
- *Vibrio* infection
  - *V. vulnificus*
    - Hemorrhagic bullae that evolve into ulcers with skin necrosis
- *Aeromonas* spp. infection
  - Water contamination
  - Cause a variety of infections beyond cellulitis
  - Rapidly progressing
    - Hemorrhagic bullae and skin necrosis
  - Medicinal leech therapy

Bacteria (Cont.)

- Borreliosis–Lyme disease
  - *B. burgdorferi*
    - Erythema migrans (EM)
- *Treponema* infection–Syphilis
  - *T. pallidium* subsp. *palladium*
    - Primary syphilis–painless chancre
    - Secondary syphilis–maculopapular rash involving skin and mucous membranes
- *Mycoplasma*
  - *M. pneumoniae*
    - Maculopapular and vesicular rashes
    - Erythema nodosum and erythema multiforme

EM Rash of Lyme Disease

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Penile Syphilitic Chancre Caused by *T. pallidium* spp. *pallidum*

The Rash of Secondary Syphilis

Zoonoses

- Diseases transmitted to humans by wild or domestic animals
- This section examines the more common systemic bacterial zoonoses that have significant dermatologic manifestations.

Rickettsiosis

- Causative agent–Rickettsiae
  - Characterized by the type and distribution of the associated skin rash and presence or absence of a black eschar at the vector bite site
    - *R. rickettsii*: Rocky mountain spotted fever (RMSF)
    - *R. conorii:* Boutonneuse fever (Mediterranean spotted fever)
    - *R. akari :* Rickettsialpox
    - *R. prowazekii, R. typhi*: Typhus fever
    - *Orientia tsutsugamushi*: Scrub fever

Rickettsiosis

- Common symptoms—high fever, chills, malaise, headache, myalgias, skin rash, and conjunctival injection

Leptospirosis

- Causative agent–*Leptospira interrogans*
  - Carried in the renal systems of rodents and other mammals including dogs and livestock
  - Maculopapular rash that may become hemorrhagic
  - Commonly involves the kidneys, liver and CNS
  - Can be self-limited illness or fatal with renal and liver failure and pneumonia

Bartonellosis

- Most common causative agents
  - *Bartonella henselae*–cause of cat scratch disease (CSD)
  - *Bartonella quintana*
- Both species can cause bacteremia, endocarditis, dermatologic disease of bartonellosis, bacillary angiomatosis (BA)

Rat Bite Fever

- Also known as streptobacillosis
  - Caused by *Streptobacillus moniliformis*
  - Spirillosis caused by *Streptobacillus minus*
- Both organisms are normal rodent oral biota.
- An abrupt onset of fever and chills, headache, and muscle pain if followed by rash (petechial, vesicular, or pustular) mostly in extremities

Tularemia

- Also known as rabbit fever
  - Caused by *Francisella tularensis*
- Six forms
  - Glandular
  - Ulceroglandular
  - Oculoglandular
  - Pneumonic
  - Oropharyngeal
  - Septic or typhoidal

Tularemia (Cont.)

- Type and severity of disease varies and is dependent on
  - Strain of infecting bacteria, dose, and route of infection
- Most common form is ulceroglandular.
  - Infection is inoculated directly into the skin after handling infected animals or after insect bite.
  - Painless indolent ulcer often on the hand that may evolve in several directions

Mycobacteria
Nontuberculous Mycobacteria

- Nontuberculous mycobacteria (NTM) infections may become disseminated.
  - Usually occurs in the setting of impaired immune function as in patients with HIV and cancer
  - Patients with central venous catheters may develop NTM catheter-related infections and can disseminate hematogenously to various organs including the skin.
  - Causative agents
    - *M. fortuitum, M. chelonae, M. abscessus,* and *M. mucogenicum*

Subcutaneous Nodules and Cellulitis Caused by Disseminated *M. chelonae*

Mycobacteria Tuberculosis

- *Mycobacterium tuberculosis* (MTB) can spread to the skin through the lymphatic system and bloodstream to distant sites and cause a variety of skin manifestations.
- Characteristics
  - Nodule swellings of the skin forming tuberculosis gummas (skin abscesses) or lupus vulgaris (sharply circumscribed, red-brown plaques or ulcers of the head and neck)
    - Can destroy cartilage of the nose or ears

Leprosy

- Also known as Hansen disease
- Caused by *M. leprae*
- There appears to be genetic factors that influence susceptibility to leprosy and the disease manifestations.
- Classic skin manifestation
  - Circumscribed, hypopigmented, or less commonly, hyperpigmented macule

Hypopigmented Macules of Leprosy

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Mycobacteria
Leprosy (Cont.)

- Two polar types of Hansen disease
  - Tuberculoid or lepromatus
- Three recognized gradations between the two polar types
- Classification is based on
  - Number and appearance of skin lesions, nerve involvement, and systemic or mucosal involvement

Mycobacteria
Leprosy (Cont.)

- Tuberculoid
  - Few skin lesions with paucity of mycobacteria in the lesions
  - Strong host cell-mediated immune response with extensive lymphocytic infiltration and granulomas
- Lepromatous
  - Several lesions with many mycobacteria
  - Infiltration of peripheral nerves
  - Poor cell-mediated response with fewer lymphocytes and granulomas

Candidiasis

- Skin lesions can be a clue to the diagnosis of invasive forms of *Candida* infection.
- Appearance of associated rash
  - An erythematous maculopapular, pustular, or nodular rash that represent subcutaneous *Candida* abscesses
- Skin biopsy will reveal fungal pseudohyphae with inflammatory cells.
- Specimens of choice for ID–aspirate/biopsy

Systemic Dimorphic Fungi and Molds

- *Sporothrix schenckii, Histoplasma capsulatum, Blastomyces dermatitidis,* and *Coccidioides immitis*
  - Cause disease in healthy hosts
- *Aspergillus*–opportunistic dimorphic fungi
- *Histoplasma, Blastomyces,* and *Coccidioides*
  - Enter via the respiratory tract and cause pneumonia and can become systemic
  - Skin is the most common extrapulmonary site of *Blastomyces* infection.

Nodular Skin Lesion Caused by *Blastomyces dermatitidis*

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Clinical & Diagnostic Microbiology

Skin/Soft Tissue (Wound) Infections
Viral Infections

Overview

- Viruses can produce localized or disseminated disease.
- In some cases, viruses cause chronic infection by evading the host immune system (e.g., HIV, hepatitis C virus).
- Can cause direct damage to tissues or evoke an immune response that leads to disease manifestations

Rubeola and Rubella

- Rubeola
  - Measles–paramyxovirus
    - Koplik's spots –small red patches with central bluish-gray specks on the buccal mucosa
- Rubella
  - German measles
    - Nonspecific maculopapular rash begins on the face and moves down the body.

Parvovirus B19 and Enteroviral Infections

- Parvovirus B19–one of the most common exanthems of childhood
  - Erythema infectiosum (Fifth's disease)
    - Bright red rash of the face: "slapped cheek"
      - Followed by a fine lacelike rash on the trunk or extremities
- Enteroviral infections
  - Coxsackieviruses and echoviruses
    - Cause of many different exanthems primarily in children and infants
    - Associated rashes are grouped as rubelliform (resembling rubella or measles) ~~or~~, roseoliform (resembling roseola) or herpetiform resembling herpes.

Varicella-Zoster Viral Infections

- Causative agent of chickenpox
- Infection progression
  - Skin lesions become apparent about 2 weeks after exposure.
  - Lesions begin as vesicles or small blisters and become pustular or rupture and form eschar over a few days.

Varicella-Zoster Viral Infections

- Infection progression
  - Rash starts on the trunk and face and spreads to the extremities.
  - More severe and systemic in adults.
  - Reactivation later in life is called shingles.

Hemorrhagic Vesicular Lesions of Herpes Zoster

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Herpes Simplex Viral Infection

- Vesicular skin lesions at the site of infection
  - Herpes simplex 1 (HSV-1) and herpes simplex 2 (HSV-2)
- Initial infection may lead to
  - Characteristic vesicular skin lesions at the site of infection or may be asymptomatic
- Virus enters nearby neurons and leads to a livelong latent infection in neuronal ganglia that can reactivate under various conditions.

Herpes Simplex Viral Infection (Cont.)

- HSV-1
  - May present as severe ulcerative gingivostomatitis and pharyngitis and occurs in children younger than age 5 years
  - Fever with systemic toxicity
  - Common manifestation of HSV reactivation
    - Fever blisters or cold sores
- Other notable example of cutaneous manifestations
  - Eczema herpeticum, erythema multiforme, herptic whitlow or primary herpetic lesions of the finger

Eczema Herpeticum Caused by Herpes Simplex Virus

Herpes Whitlow
(Herpetic Lesions of the Finger)

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Herpes Simplex Viral Infection (Cont.)

- HSV-2
  - Transmitted by sexual contact and results in primary and secondary recurrent herpes genitalis and perirectal infections
  - Primary infection
    - Symptoms: fever, myalgias, inguinal lymphadopathy
    - Potential complications: urethritis and meningitis

Other Herpesviruses

- Mononucleosis syndrome
  - Causative agents
    - Epstein-Barr virus (EBV)
    - Cytomegalovirus (CMV)
  - Sometimes associated with nonspecific rashes
    - Usually maculopapular
  - EBV can also cause petechial or urticarial rashes and may be a trigger for erythema multiforme

HHV-6

- Human herpes virus 6 (HHV-6)
  - Roseola infantum (exanthem subitum or sixth's disease)–febrile syndrome in infants and children
  - Maculopapular rash begins on the trunk and spreads outward.

KSHV

- Kaposi sarcoma-associated herpesvirus (KSHV)–associated with HIV
  - Also known as human herpesvirus 8 (HHV-8)
  - Vascular neoplasm
  - Appearance of erythematous or purplish nodules and plaques that are indurated

Large Hyperpigmented Plaque of Kaposi Sarcoma

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Molluscum Contagiosum

- Poxvirus
- Common skin disease
- Causes small, firm, waxy papules
- Occasional giant lesions form
- Transmitted person-to-person
  - Via sexual contact
  - One body area to another by contact
- Appears on the genitalia, face, or perirectal area

Giant Molluscum Contagiosum

Orf and Milker Nodule

- Parapoxviruses
- Common pathogens of animals
  - Zoonotic occupational diseases
- Skin lesions are identical
  - Solitary papule, pustule, or nodule that can drain and develops central crusting
  - Can be associated with local lymphadenitis
  - Present on hands, arms, face

Human Papillomavirus

- Papillomaviruses cause a variety of skin and mucous membrane lesions that range in severity from benign growths to malignancies.
- Over 200 types of human papillomaviruses (HPVs) with more than 40 types that infect the oropharyngeal or genital regions
- Infections may be asymptomatic or lead to warts of benign skin or mucosal cell proliferations.

Human Papillomavirus (Cont.)

- Genital lesions associated with HPV
  - Condyloma acuminata–cauliflower-like fleshy growths seen in moist genital and perianal regions-and flat papillomas of the cervix
- Transmission of HPV from mother to infant via the birth canal can lead to
  - Laryngeal papillomas on the vocal cords and epiglottis of children
- Connection to cancers
  - Penile, vaginal, cervical, oral, anorectal

Alphaviruses

- Several members are mosquito-borne and cause clinically indistinguishable syndromes of fever, arthralgia and rash.
- Rash usually starts on the face and neck and as it spreads, it becomes macular or maculopapular and may be pruritic.
- Other symptoms include headache, severe arthralgias, retro-orbital pain, pharyngitis, and vomiting.

Hemorrhagic Fever Viruses

- Flaviviridae
  - Yellow fever, dengue virus, Zika virus
- Arenaviridae
  - Junín, Lassa, Machupo viruses
- Bunyaviridae
  - Hantavirus, Crimean-Congo hemorrhagic fever (CCHF), Rift Valley fever viruses
- Filoviridae
  - Ebola, Marburg viruses

Hemorrhagic Fever Viruses

- General symptoms of characteristic viral syndrome
  - Fever, headache, myalgias, arthralgias, nausea and vomiting, abdominal pain, and skin manifestations
- Other possible symptoms
  - Severe bleeding (nasal or GI)
  - Bleeding into the skin resulting in petechiae, purpura, ecchymoses

Facial Rash of Dengue Fever

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Severe Acute Respiratory Syndrome-Cornoavirus-2 (SARS-CoV-2)

- First reported in Wuhan, China in 2019
- Spread around the world and resulted in a global pandemic known as Coronavirus Disease 2019 (COVID-19)
- RNA coronavirus
  - Infects the respiratory tract and can cause severe pneumonia
  - Can affect many extrapulmonary organ systems including the skin

Severe Acute Respiratory Syndrome-Cornoavirus-2 (SARS-CoV-2)-(Cont.)

- Dermatologic manifestations
  - Non-specific maculopapular exanthems
  - Urticaria
  - Erythema multiforme
  - Purpura
  - Livedo reticularis (varicella-like lacy pattern of red-blue skin discoloration
  - Chillblain-like lesions (COVID-toes)- characteristic finding that involves the feet and less commonly the hands

Clinical & Diagnostic Microbiology

Skin/Soft Tissue (Wound) Infections
Parasitic Infections

Overview

- Three main parasitic infection categories
  - Helminthic
  - Protozoal
  - Ectoparasitic
- Some of these infections have major or minor dermatologic manifestations as part of the illnesses they cause.
- Common infections, mainly involving helminths and ectoparasites, are covered here.

Helminths - Schistosomiasis

- Trematodes (flatworms or flukes)
- Dermatitis at the entrance site usually seen when parasites infect humans (in water)
- Pruritic popular eruption known as cercarial dermatitis or swimmer's itch
  - Dermatitis is usually self-limited

Helminths - Schistosomiasis

- Acute schistosomiasis caused by human schistosomes (Katayama fever)
  - Sometimes associated with a similar pruritic rash as the site of skin penetration by cerceriae

Helminths – *Strongyloides* Infection

- Causative agent
  - *Strongyloides stercoralis* (roundworm or nematode)
- Transient dermatitis
  - Occurs when free-living larvae in soil penetrate the skin of humans migrate to the vasculature on the way to the lung and then on to the GI tract
- Autoinfections may affect the skin causing a rash called larva currens.
  - Migratory, serpiginous, and pruritic eruption
- Urticaria may appear as larvae penetrate the skin in the perianal area.

Helminths - Lymphatic Filariasis

- Causative agents
  - *Wuchereria bancrofti, Brugia malayi, Brugia timori*
- Infective stage–larvae
  - Transmitted by mosquito bites
- Adult worms reside in the lymph nodes and lymphatic vessels of the legs and male genitalia (elephantiasis).
- Fever and inflammation of associated lymph nodes can occur and may be the result of secondary bacterial or fungal infection.

Lymphatic Filariasis (Elephantiasis)

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

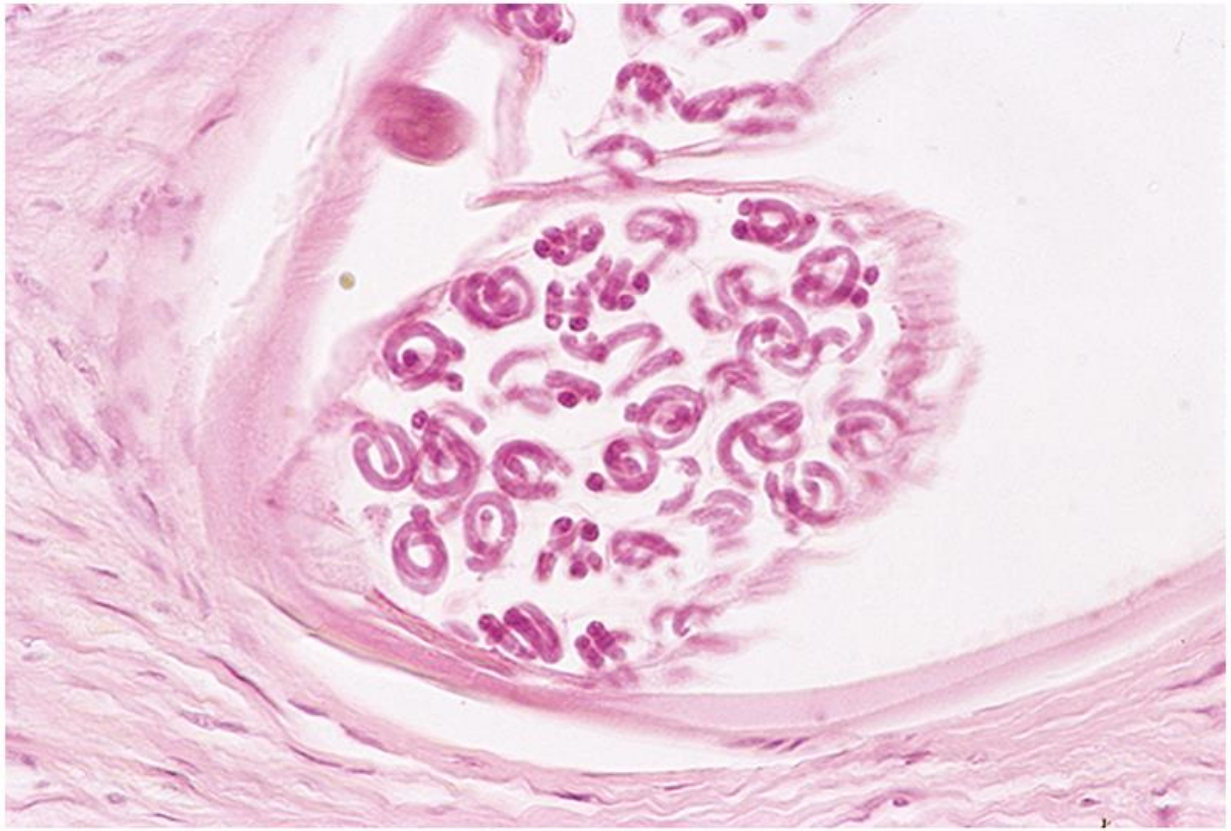
Helminths - Filariasis (Cont.)

- Onchocerciasis, also known as river blindness
  - Causative agent–*Onchocerca volvulus*
    - Transmitted by blackflies
  - Causes subcutaneous nodules and river blindness
- After larval transmission, larvae develop into adult worms in the subcutaneous tissues forming subdermal nodules (onchocercomata).
- Microfilariae migration through the skin causes an intensely itchy rash and skin edema.

Heliminths - Filariasis (Cont.)

- Most important manifestation of onchocerciasis
  - Results from larval infiltration of the eye
  - An inflammatory response occurs on death of parasite larvae, leading to visual disturbances and blindness

Tissue Cross Section of Nodule Containing *Onchocerca volvulus* Microfilariae



Helminths - Drancunculiasis

- Causative agent–*Drancunculus medinensis*
- After parasite ingestion, larvae migrate to small intestine where they penetrate the intestinal wall and reside in peritoneal and retroperitoneal spaces.
- Adult worms migrate to the skin, particularly the legs, where the cause painful blisters and can emerge through the skin.
- Cellulitis resulting from secondary infection can develop.

Helminths - Hookworm Infection

- Causative agents
  - *Ancylostoma duodenale*
  - *Necator americanus*
  - *Ancylostoma ceylanicum*, a zoonosis
- Larvae penetrate the skin to initiative infection.
  - Results in ground itch at entrance site
- Dog and cat hookworms can also penetrate the skin but are unable to develop further.
  - Causes dermatitis known as cutaneous larva migrans (CLM) or creeping eruption

Helminths - Leishmaniasis

- Most *Leishmania* infections are limited to the skin and adjacent lymph nodes.
- Cutaneous leishmaniasis develops days to months after bite of an infected sandfly.
  - Painless papule that enlarges and may ulcerate
  - Lesions vary in appearance.
  - Local dissemination of infection can occur.
  - Widespread hematogenous lesions of the skin are associated with mucosal involvement.
  - Disfiguring scarring and secondary infection possible.

Helminths -Leishmaniasis

- Visceral leishmaniasis
  - Also known as kala-azar
  - Severe form of disease with certain species
    - *Leishmania infantum* and *Leishmania donovani*
  - Dissemination of parasite to bone marrow, liver, spleen, other organs
- Transmission from mother to child or through transfusion has occurred

Facial Ulceration Caused by *Leishmania* infection

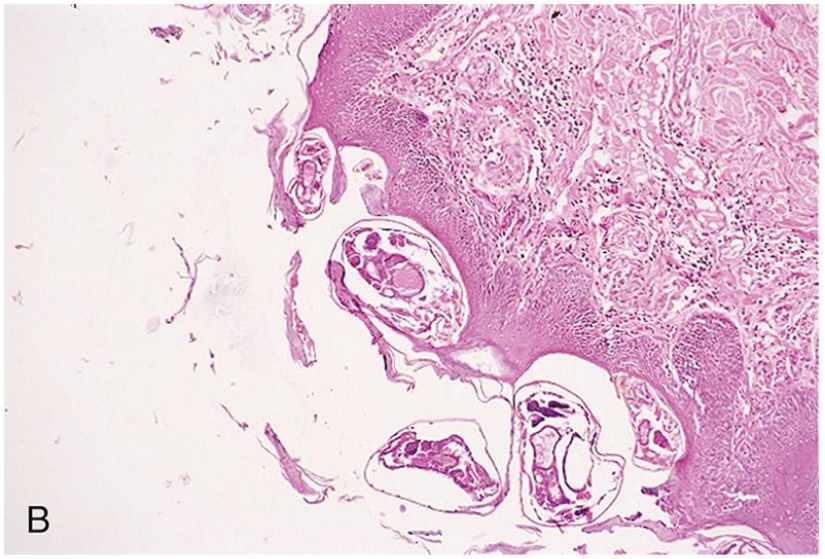
Ectoparasites

- Examples
  - Lice (pediculosis)
  - Mites (scabies)
  - Fleas
  - Flies
  - Ticks
  - Bedbugs
  - Chiggers

Ectoparasites (Cont.)

- Ectoparasites attach to or burrow in the skin and can remain there for weeks to months.
- Dermatologic features of ectoparasite infestation include
  - Severe itching
  - Formation of papules, vesicles, nodules, linear burrows, excoriations of the skin and scalp

Sarcoptes scabiei Adult and Lesion



Thick, Scaly Plaques of Norwegian Scabies

Courtesy Dr. Gail Reid, Loyola University Medical Center, Maywood, IL.

Morphology Consistent with *Phthirus pubis* (Crab Louse)

Clinical & Diagnostic Microbiology

Skin/Soft Tissue (Wound) Infections
Immune or Toxin-Mediated Dermatologic Manifestations of Infectious Agents

Immune-Mediated Cutaneous Disease Disseminated Intravascular Coagulation (Cont.)

- Skin manifestations
  - Petechiae of the skin resulting from thrombi development in organs
  - Purpura fulminans can occur in
    - Meningococcemia
    - Septicemia with *S. aureus*, *S. pneumoniae, H. influenzae*
    - Characterized by rapidly developing skin hemorrhage, skin necrosis, peripheral gangrene accompanied by shock syndrome resulting in death or amputation.

Petechial Lesions in Meningococcemia

Immune-Mediated Cutaneous Disease Disseminated Intravascular Coagulation (Cont.)

- Vasculitis
  - Palpable purpura over the lower extremities
- Infection-related immune complex-induced disease
  - Often seen in endocarditis with cutaneous purpura
  - Painful, small skin nodules located on finger pads and toes possible (Osler's nodes)
  - Causative agents
    - Staphylococci, streptococci
    - Less frequent: gram-negative bacteria, *Candida*

Hemorrhagic Vasculitic Lesions of *Staphylococcus aureus* Endocarditis

Toxin-Mediated Cutaneous Disease

- Certain bacteria can produce toxins that affect the skin, resulting in distinct clinical syndromes
  - Staphylococci and streptococci
- Infections may start as primary skin and soft tissue infections or may initially affect another site, with subsequent involvement of the skin caused by the effects of circulating toxin.

Toxin-Mediated Cutaneous Disease Staphylococcal Scalded Skin Syndrome

- Abbreviated SSSS
- Blistering skin condition mostly seen in children under age 5 years
- Causative agents–certain strains of *S. aureus* that can produce exfoliative toxins
- Clinical features
  - Fever, skin tenderness, a scarlatiniform rash followed by extensive formation of bullae and exfoliation

Toxin-Mediated Cutaneous Disease SSSS (Cont.)

- Sometimes occurs in adults with underlying illness such as
  - Renal disease, cancer, IV drug use, HIV, diabetes mellitus
- Toxins act on stratum granulosum of epidermis and thus does not affect mucosal tissue
- Characteristic–Nikolsky sign
  - Separation of the epidermal layer on gentile stroking

Toxin-Mediated Cutaneous Disease SSSS (Cont.)

- Large flaccid blisters form and rupture
  - Causes the skin to denude and peel off in sheets leaving bright red underlying skin exposed
- Secondary bacterial infection and fluid loss occur.
  - Skin generally heals without scarring.
- Nosocomial epidemics of SSS have been reported in nurseries.

Toxin-Mediated Cutaneous Disease Toxic Shock Syndrome (TSS)

- Caused by production of staphylococcal exotoxins, referred to as superantigens
  - They can cause widespread non-antigen-specific activation of T lymphocytes.
  - Superantigens include toxic shock syndrome toxin 1 (TSST-1) and staphylococcal enterotoxins.
  - Once activated by these superantigens, cytokines are released by lymphocytes and macrophages.

Toxin-Mediated Cutaneous DiseaseTSS (Cont.)

- Settings in which nonmenstrual TSS occurs
  - Postpartum
  - After influenza infection
  - In association with surgical wound infections
  - Contaminated nasal packing in patients with nosebleeds
- TSS clinical presentation
  - A diffuse sunburn-like erythroderma appears early on accompanied by fever, hypotension, evidence of multiorgan dysfunction

Toxin-Mediated Cutaneous Disease TSS (Cont.)

- TSS clinical presentation
  - Desquamation of the skin, especially on the palms and soles occurs during the convalescent stage of illness
- *S. aureus* may be recovered in blood cultures and staphylcocci may be cultured from the initial site of infection.

Toxin-Mediated Cutaneous Disease TSS (Cont.)

- Streptococcal TSS caused by GAS (*S. pyogenes*)
  - Occurs whenever exotoxin-producing strains of GAS infect or colonize the skin or mucous membranes, particularly strains producing streptococcal pyrogenic exotoxins (SPEs).
  - Most cases have been in young, otherwise healthy adults.
    - Lack of protective immunity may be a risk factor.

Toxin-Mediated Cutaneous Disease TSS (Cont.)

- Streptococcal TSS caused by GAS (*S. pyogenes*)
  - Portal of entry is typically the skin with cellulitis that progresses rapidly.
  - Many invasive streptococcal infections do not have a recognized portal of entry.
  - Subsequent signs and symptoms are like that of staphylococcal TSS.
  - Blood cultures are more often positive in GAS TSS than in staphylococcal TSS.

Toxin-Mediated Cutaneous Disease Scarlet Fever

- Scarlet fever–a form of GAS disease when the infecting strain produces SPEs
- Occurs mostly in children, concomitantly with pharyngeal infection
- Fever is typically present.
- The rash starts on the chest and spreads outward.

Toxin-Mediated Cutaneous Disease Scarlet Fever (Cont.)

- Red, sandpaper-textured rash often on the neck and chest and in skin folds
- Rash does not involve the face but there is flushing of the skin with circumoral pallor.
- Strawberry tongue
- Convalescence
  - Desquamation of the skin occurs, especially on the hands and feet.

Clinical & Diagnostic Microbiology

Skin/Soft Tissue (Wound) Infections
Laboratory Diagnosis

Laboratory Diagnosis Specimens

- Swabs
  - Generally yield colonizing or contaminating bacteria
- Deep aspirates and biopsies
  - Better specimens
- Pustules and vesicles
  - Exudates produce better results.

Laboratory Diagnosis
Direct Examination and Culture

- Direct examination
  - Gram stain if bacteria suspected
  - Potassium hydroxide (KOH) and/or calcofluor white if fungi suspected
  - Acid fast if mycobacteria suspected
  - Modified acid fast if *Nocardia* spp. is suspected
  - Fluorescent stains
- Culture
  - Enriched media to isolate all organisms
  - Selective media to detect specific pathogens

Laboratory Diagnosis
Viruses and Nonculture Tests

- Nonculture-based tests
  - PCR
  - Antigen detection
  - MALDI-TOF on isolates
  - Serum antibody tests

Points to Remember

- The skin, skin structures, and normal microbiota play a significant role in protecting the host against microbial invasion and disease.
- The normal skin biota can be involved in the pathogenesis of skin and skin structure infections, particularly if the integrity of the skin is compromised.

Points to Remember (Cont.)

- There is an extensive variety of skin and soft tissue infections, which can be classified according to the type of skin lesion produced, the causative organism, or the pathogenesis of the infection (e.g., as a primary entity or secondary to a preexisting infection or systemic manifestation).

Points to Remember (Cont.)

- Bacteria, viruses, fungi, and parasites are all important causes of skin and soft tissue infections.
- *S. aureus* and S. *pyogenes* are common causes of pyoderma.
- Virulence factors of disease-producing organisms (e.g., toxins) can enable the organisms to evade host defense mechanisms, which can result in severe manifestations of infection.

Points to Remember (Cont.)

- A compromised immune system can lead to more severe or unusual manifestations of infection and can allow normally innocuous organisms to be pathogenic.
- The occurrence of disease in a host is a function of the underlying host's immunity and virulence of the pathogen.

Points to Remember (Cont.)

- The method and site of laboratory specimen collection, quality of the clinical specimen, and clinical context are all important factors to consider when distinguishing between colonization and infection by microorganisms.

Points to Remember (Cont.)

- Proper specimen collection and laboratory processing of specimens are factors critical to the success of making a microbiological diagnosis of infection.