Skin and Soft Tissue Infections

Richard H. Glew, MD, Professor of Medicine, Molecular Genetics, and Microbiology, Vice Chair of Medicine for Undergraduate Education and Faculty Affairs, University of Massachusetts Medical School, Worcester

Superficial focal skin and soft tissue infections (SSTIs): generally treated on outpatient basis; primarily due to *Staphylococcus aureus*; types include impetigo (most often seen in children during summer; related to minor trauma of skin, reduced hygiene, and sweating; extremely superficial), folliculitis (tracks down hair follicle into dermis), and furuncles and carbuncles (may evolve from folliculitic lesions; occur in subcutaneous plane; furuncle single boil; carbuncle multiple boils that coalesce); *impetigo* — characterized by honey-colored crust (skin underneath normal); bullous sub-type characterized by multiple thin-walled blisters filled with honey-colored fluid; *folliculitis* — characterized by hair follicle surrounded by red and/or purulent lesion (usually multiple); folliculitis, furuncles, and carbuncles tend to occur in hairy areas prone to abrasion and rubbing; *boils* — 3-dimensional infections; open spontaneously; usually contain hard core and small amount of surrounding cellulitis; penetrate dermis and scar when healed; carbuncles commonly form in areas at which rubbing and sweating occur, eg, back of neck, inner thighs; *herpes gladiatorum* — acquired by exogenous infection of traumatized skin; occurs in ≈66% of high school and college wrestlers

Pyoderma: superficial purulent infection; *local care* — maintain personal hygiene (*ie*, shower frequently); use towels once; reduce frequency and extent of body shaving; avoid tight clothing; apply chlorhexidine lotion (*eg*, Betasept, Chlorostat, Hibiclen); speaker recommends applying chlorhexidine lotion over entire body immediately after shower (starting in most affected area) and rinsing after 2 min (daily protocol if acute, then wean to 2-3 times/wk); *oral antibiotics (ABX)* — treat acute infections; while culture pending, cover for methicillin-resistant and methicillin-sensitive *S aureus* (MRSA and MSSA); doxycycline more effective for MRSA than trimethoprim-sulfamethoxazole (TMP-SMX; *eg*, Bactrim, Bethaprim, Sulfatrim) and less allergenic; linezolid (*Zyvox*) used if patient unable to take doxycycline, minocycline, or TMP-SMX; for MSSA, treat with dicloxacillin or cephalaxin (*eg*, Biocef, Kellex, Panixine); *regimen for chronic recurrent folliculitis or furunculosis* — local care plus antibiotic measures; mupirocin nasal (Bactroban); stricter avoidance measures; mupirocin nasal (Bactroban); chlorhexidine lotion over entire body immediately after shower (starting in most affected area); use towels once; chlorine or bleach (5% solution) used to eradicate infection until proven otherwise; use chlorine or bleach (5% solution) to wash clothing; apply chlorhexidine lotion (*eg*, Hibiclens); speaker recommends applying chlorhexidine lotion over entire body immediately after shower (starting in most affected area); use towels once; chlorine or bleach (5% solution) used to eradicate infection until proven otherwise; use chlorine or bleach (5% solution) to wash clothing; apply chlorhexidine lotion (*eg*, Hibiclens)

Cellulitis should be admitted for intravenous therapy and antibiotic regimen for chronic recurrent cellulitis: *local care plus antibiotic measures*; mupirocin nasal (Bactroban); chlorhexidine lotion over entire body immediately after shower (starting in most affected area); use towels once; chlorine or bleach (5% solution) used to eradicate infection until proven otherwise; use chlorine or bleach (5% solution) to wash clothing; apply chlorhexidine lotion (*eg*, Hibiclens); speaker recommends applying chlorhexidine lotion over entire body immediately after shower (starting in most affected area); use towels once; chlorine or bleach (5% solution) used to eradicate infection until proven otherwise; use chlorine or bleach (5% solution) to wash clothing; apply chlorhexidine lotion (*eg*, Hibiclens)

Predisposing conditions for acute and chronic recurrent cellulitis: venous and/or lymphatic insufficiency; arterial insufficiency; obesity; diabetes mellitus (*DM*); neuropathy; vasculopathy; linea pedis

Animal bites: *dog bites* — ≈10% become infected; bone and joint infections rare; colonized with mixed flora; *cat bites* — ≈33% become infected

Therapy for cellulitis: if no suggestion infection caused by *S aureus*, treat with cefazolin or nafcillin plus elevation of extremity; if no improvement within 1 to 2 days, switch to coverage for MRSA; if open wound, purulent drainage, foreign body, or penetrating trauma present, assume *S aureus* infection until proven otherwise; culture wound and pus and start vancomycin, daptomycin, or linezolid; if caused by cat bite, treat with ampicillin or ceftriaxone; most patients with cellulitis should be admitted for intravenous therapy and mandatory elevation of extremity

Prevention of recurrent cellulitis: treat predisposing conditions when possible; eliminate edema by elevation of affected extremity during day; *low-dose suppression* — used in patients with frequent recurrent cellulitis (due to, *eg*, edema resulting from radical mastectomy); targets *Streptococcus*; drug of choice amoxicillin twice daily (if patient improves after 1-2 yr, reduce to once daily); use chlorhexidine lotion 2 times/wk

Necrotizing SSTIs

Clinical clues: *systemic* — multiorgan failure; altered mental status; shock; systemic toxicity; markedly elevated white blood cell count (*WBC*); *local* — can be severely painful or painless; gas in soft tissues (*confirm with x-ray*); rapid spread via fascial planes; color other than red (*eg*, maroon, blue, purple, black); eschar; sloughing

Monobacterial infections: *immunocompetent hosts* — groups A and B β-hemolytic streptococci more commonly cause acute infection eradicated; clindamycin most effective agent for MSSA infection, but also most strongly associated with *Clostridium difficile* colitis

Superficial spreading SSTIs: *cellulitis* — common indication for hospital admission; recurrence common; characterized by red extremity (most commonly in lower extremity); *erysipelas* — subset of cellulitis; associated with higher rate of bacteremia and more rapid spread; occurs within dermis and destroys lymphatics; *lymphangitis* — characterized by red streaks running up extremity, proximal to SSTI; *lymphadenitis* — infection of lymph node; more commonly due to staphylococcal than streptococcal infection; all other superficial spreading SSTIs (ie, cellulitis, erysipelas, and lymphangitis) more commonly streptococcal than staphylococcal

Educational Objectives

The goal of this program is to improve the management of skin and soft tissue infections (SSTIs) and infections associated with prosthetic devices. After hearing and assimilating this program, the clinician will be better able to:

1. Prescribe effective antibiotic therapy for superficial focal, superficial spreading, and deep necrotizing SSTIs.
2. Differentiate between cellulitis caused by streptococci and that caused by *Staphylococcus aureus*.
3. Recognize systemic and local signs that suggest a necrotizing SIT.
4. Diagnose an infection associated with a cardiac implantable electrophysiologic device or prosthetic joint.
5. Identify infections associated with a prosthetic joint that can be managed with retention of implant.

Faculty Disclosure

In adherence to ACCME Standards for Commercial Support, Audio-Digest requires all faculty and members of the planning committee to disclose relevant financial relationships within the past 12 months that might create any personal conflicts of interest. Any identified conflicts were resolved to ensure that this educational activity promotes quality in health care and not a proprietary business or commercial interest. For this program, the following has been disclosed: Dr. Peacock holds stock in Pfizer. Dr. Glew and the planning committee reported nothing to disclose.
cellulitis rather than deeper infections (eg, fasciitis, myositis), usually with little or no antecedent trauma; clostridial myonecrosis or cellulitis rarely spontaneous, ie, occurs in dead flesh (due to, eg, crushing injury, gunshot wound); spontaneous clostridial myonecrosis can occur in patients with underlying malignancy of colon; immunocompromised hosts — patient with cirrhosis who ingests raw shellfish or exposes open wound to brackish water can develop bactere mia and multifocal skin necrosis with Vibrio vulnificus; dog bites or dog licking open wound can result in necrosis due to Capnocytophaga canimorsus; patient with acute leukemia can develop multifocal necrotizing bacteremic infection with Pseudomonas aeruginosa

Streptococcal gangrene: occurs in healthy people; infection can be subcutaneous or in deeper plane; causative organisms produce exotoxins, some of which act as superantigens (trigger massive cytokine response that leads to multiorgan failure); key point — in addition to receiving systemic support and ABX, patient with suspected necrotizing SSTI must be seen immediately for aggressive surgery; therapy — clindamycin for 48 hr plus cell wall-active agent (eg, vancomycin, ceph alosporin, non-β-lactam [eg, daptomycin, linezolid]); surgical debridement mandatory

Necrotizing clostridial infection: most commonly occurs in setting of devitalizing soft-tissue injury; management — clostridial myonecrosis often monobacterial process; however, broad ABX coverage (for gram-negative bacteria, anaerobes, Staphylococcus, and β-hemolytic streptococci; in patients with DM — classically occurs in distal lower extremities; patient often has neuropathic ulcer being ignored or not improving with treatment; patients can also get spontaneous perineal necrotizing fasciitis due to same microbiology; bedridden patients can become infected at pressure points (eg, sacrum, trochanter); therapy — surgery critical; broad-spectrum ABX used to target gram-negative bacteria, gram-positive cocci, MRSA, and anaerobes

Prophylaxis for C difficile infection in patients on long-term ABX: speaker recommends probiotics (eg, saccharomyces, lactobacillus); multibacterial yogurt simplest and best

Infections Associated with Implanted Devices

James E. Peacock Jr, MD, Professor of Internal Medicine-Infectious Diseases, Wake Forest School of Medicine, Winston-Salem, NC

Overview: ≤4 million prosthetic devices surgically implanted each year in United States; risk for infection after implantation ranges from <1% to 50% (in general, risk greater with reimplantation than with primary implantation)

Pathogenesis of infections associated with prosthetic devices: implantation of device; formation of “conditioning layer” on surface of prosthesis; adherence of planktonic bacteria (eg, coagulase-negative staphylococci, Staphylococcus aureus) to device using specific adhesins; activation of inducible genes by bacteria; elaboration of extracellular glycocalyx (biofilm); formation of complex communities with cell-to-cell signaling; over time, biofilm builds and extends

Susceptibility of planktonic vs biofilm bacteria to selected ABX: S aureus — antibiotic vancomycin; minimum inhibitory concentration (MIC) for planktonic organisms 2 mg/L, compared with 20 mg/L for biofilm bacteria; P aeruginosa — antibiotic imipenem; MIC for planktonic organisms 1 mg/L, compared with >1000 mg/L for biofilm bacteria

Infections Associated with Cardiac Implantable Electrophysiologic Devices (CIEDs)

Introduction: rates of implantation for implantable cardioverter defibrillators (ICDs) and permanent pacemakers (PPMs) continue to increase; 70% of recipients ≥65 yr of age; most patients receiving CIEDs have multiple comorbid illnesses, and number of comorbidities has increased over time; risk for infection following implantation has increased as well (rate 1%-2%; with cumulative probability of infection higher in patients with ICDs than in those with PPMs); infections of pulse-generator pocket account for 75% to 90% of total; bloodstream infections (BSIs) and CIED-related infective endocarditis (IE) account for 10% to 25%

Pathogenesis of infections: local — contamination of pocket at initial implantation or revision; BSI — migration of infection from pocket down leads of device to bloodstream; CIED-related IE — spread of infection from pocket along leads or hematogenous seeding of leads

Risk factors: for infections associated with CIEDs — early reinterventions after initial placement; development of fever shortly after implantation; replacement of generator; for CIED-related IE — concurrent use of immunosuppressive therapies; need for hemodialysis because of chronic kidney disease; remote infection; risk for infection of CIED in patients with S aureus bacteremia 45% to 54%

Microbiology: gram-positive cocci predominant causative organisms; staphylococci responsible for ≤75% of pocket infections and ≤90% of CIED-related IE

Signs of infections associated with CIEDs: local inflammation of pocket (occurs in 50%-66% of patients); erosion of device through skin (occurs in 15%-25% of patients); unexplained fevers, particularly after revision of device; unexplained bacteremia

Approach to diagnosis: obtain blood cultures before ABX; if device explanted, obtain cultures of pocket tissue and lead tips; cardiac imaging study — perform for all patients; guidelines suggest transesophageal echocardiography [TEE]; some cardiologists prefer transthoracic echocardiography [TTE], but even if TTE shows lead-adherent vegetation, patient should still undergo TEE to rule out valvular endocarditis

Antimicrobial management after removal of device: pocket infections and CIED-associated BSIs should be treated for 10 to 14 days; more complicated CIED infections (eg, IE and/or metastatic foci) should be treated for 4 to 6 wk

Removal of infected CIED: explanation recommended for all patients with — definite valvular or lead IE; pocket infection; valvular IE (even without evidence of vegetation on leads or device); occult staphylococcal bacteremia; may also be appropriate for patients with BSI due to gram-negative rods; CIED should only be left in patient with incisional infection that does not extend into pocket; complications of explanation — tamponade (incidence ≤3%; rarely associated with death); embolization of vegetation (incidence ≤3%; clinical sequelae minimal)

Infections Associated with Prosthetic Joints

Introduction: implantations of prosthetic joints dramatically increased over past 20 yr, with concurrent increase in risk for associated infections (average risk 1%-2%)

Diagnostic criteria: ≥2 positive cultures of same organism from synovial fluid or periprosthetic tissue; gross purulence in synovial fluid or at site of implantation; histopathology demonstrating acute inflammation; sinus tract communicating with prosthesis

Microbiology: infections due to gram-positive cocci predominant; staphylococci predominant causative organisms
Risk factors: prolonged surgery; older age; comorbidities; presence of perioperative infection or distant nonarticular infection; in setting of S aureus bacteremia, incidence of infections associated with prosthetic joints 30% to 40%.

Clinical features: early (<3 mo postsurgery) — acute onset with fever and local inflammation; usually due to S aureus or gram-negative rods; delayed (3-24 mo postsurgery) — presentation subtle; predominant symptom joint pain; due to less virulent organisms typically introduced at surgery but manifest at later date; late (>24 mo postsurgery) — onset acute or subacute; S aureus most common causative organism; mostly due to hematogenous seeding of device.

Diagnostic criteria: radiographs — loosening around prosthesis nonspecific indication of infection; analysis of synovial fluid — increased leukocytes, indications infection associated with prosthetic hip joint; culture — confirms infection; sonication of implant — new and evolving technique; data suggest comparing cultures of periprosthetic tissue to cultures of sonicate fluid can increase diagnostic yield of cultures from ≈60% to 80%.

Management: medical — cidal ABX target sessile organisms in biofilm (rifampin best; fluoroquinones may be useful); surgical — explantation performed through 1- or 2-stage procedure; incision and debridement (with retention of prostheses in selected patients); rifampin critical component of management; criteria for considering retention of implant — implantation <3 mo ago; infection hematogenous; symptoms present for <3 wk; no abscess or sinus tract; implant stable; organism can be treated with ABX that can penetrate biofilm.

Questions and Answers

Use of rifampin: resistance to rifampin develops rapidly if not used with second drug; thus, always used in combination.

Linezolid in treating infections associated with prosthetic devices: only static for staphylococci, so not cidal drug; therefore, not good choice.

Suggested Reading


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SKIN AND SOFT TISSUE INFECTIONS/INFECTIONS ASSOCIATED WITH DEVICES

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1. Which of the following superficial focal skin and soft tissue infections (SSTIs) occur in the subcutaneous plane?
   (A) Impetigo
   (B) Folliculitis
   (C) Herpes gladiatorum
   (D) Carbuncle

2. Which of the following antibiotics is more effective for treating a superficial focal skin infection caused by methicillin-resistant Staphylococcus aureus (MRSA)?
   (A) Trimethoprim-sulfamethoxazole
   (B) Doxycycline
   (C) Cephalexin
   (D) Dicloxacillin

3. All the following superficial spreading SSTIs are more commonly streptococcal than staphylococcal infections, except:
   (A) Cellulitis
   (B) Erysipelas
   (C) Lymphadenitis
   (D) Lymphangitis

4. Which of the following is the drug of choice when using low-dose suppression in the treatment of patients with frequent recurrent cellulitis?
   (A) Amoxicillin
   (B) Ampicillin
   (C) Cefazolin
   (D) Doxycycline

5. Which of the following necrotizing SSTIs most commonly occurs in the setting of a devitalizing soft tissue injury?
   (A) Streptococcal gangrene
   (B) Polymicrobial necrotizing fasciitis
   (C) Necrotizing clostridial infection
   (D) Cellulitis due to group A β-hemolytic streptococci

6. In general, the risk for infection associated with a prosthetic device is greater with _______ than with_______.
   (A) Primary implantation; reimplantation
   (B) Reimplantation; primary implantation

7. The majority of infections associated with cardiac implantable electrophysiologic devices (CIEDs) are:
   (A) Pulse-generator pocket infections
   (B) Bloodstream infections
   (C) CIED-related infective endocarditis (IE)

8. Complicated CIED infections (eg, IE and/or metastatic foci) should be treated with antibiotics for _______ after removal of the device.
   (A) 10 to 14 days
   (B) 2 to 4 wk
   (C) 4 to 6 wk
   (D) 6 to 8 wk

9. All the following statements about late infections associated with prosthetic joints are true, except:
   (A) Occur >24 mo postsurgery
   (B) Acute or subacute onset of signs and symptoms
   (C) Predominantly due to hematogenous seeding of the device
   (D) Most common causative organisms coagulase-negative staphylococci

10. Which of the following drugs best targets sessile organisms that cause infections associated with prosthetic joints?
    (A) Vancomycin
    (B) Rifampin
    (C) Linezolid
    (D) Doxycycline

Answers to Audio-Digest Internal Medicine Volume 60, Issue 01: 1-B, 2-A, 3-A, 4-D, 5-D, 6-B, 7-D, 8-A, 9-C, 10-B