



The Lady is Red: Treatment of Skin and Soft Tissue Infections (SSTIs)



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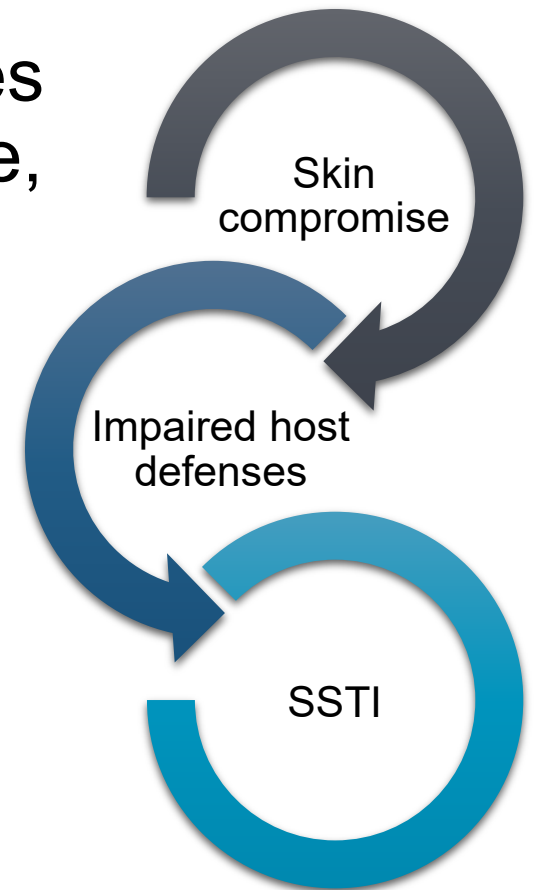
Learning Objectives

1. List the **layers and other anatomic features of the skin**, identifying which are involved in particular infections.
2. Discuss how to approach infections that may necessitate **bedside operative intervention** (e.g., incision and drainage).
3. Summarize **antimicrobial treatments** based on suspected pathogens.



Definition and Classification Systems

- **Skin and soft tissue infection (SSTI)** = microbial invasion of skin and its supporting structures due to *compromise* of skin integrity (e.g., scratch, bite, burn) and interaction of bacteria with host defenses
- Various classification systems have been proposed (e.g., depth of infection, causative pathogens)



Ki (2008), Ramakrishnan (2015), Chahine (2015), Sartelli (2018), Sartelli (2022)



Epidemiology, Cost, and Compliance

- In the US, SSTIs account for **>14 million outpatient visits annually**
 - 70-75% of cases managed in outpatient setting
- *However, **most SSTIs resolve within 7-10 days**, so difficult to know the true prevalence*
- In one retrospective chart review of ED encounters, **treatment fully complied with IDSA guidelines in only 20.1% of cases**
 - SSTIs one of the most common diagnoses after chest pain and asthma
 - Nearly 14% of cases get hospitalized with a mean stay of 3.7 days (and cost of over \$18k)

Ki (2008), Rajan (2012), Ramakrishnan (2015), Chahine (2015), Kamath (2018)



Historical Background

- Meant more for drug trials than as a clinical framework, the 1998 FDA guidelines divided SSTIs into 2 groups:
 - **Uncomplicated infections** (e.g., impetigo, erysipelas, cellulitis, furuncle)
 - **Complicated infections** (e.g., infected burn, deep-tissue infection, perirectal abscess)
 - >75 cm² of erythema, edema, or induration
 - Necrotizing fasciitis, infections associated with prosthetics, etc. were excluded
- The 2010 revision further excluded bites, decubitus ulcers, diabetic foot infections, and infections involving bones/joints



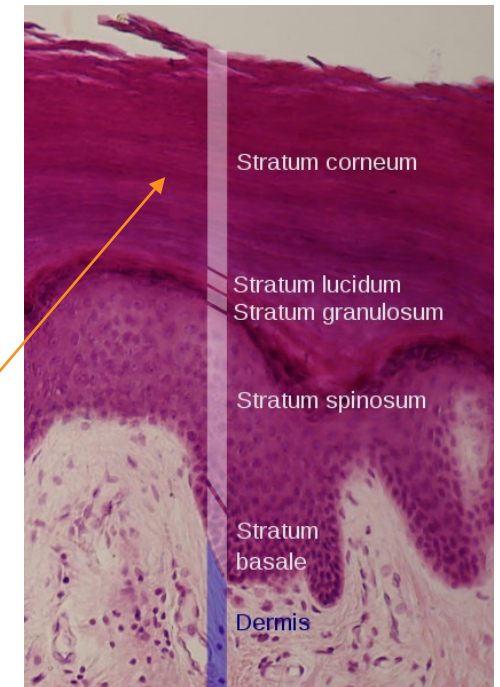
Historical Background (*con't*)

- A confusing alphabet soup followed, with the FDA eventually defining **acute bacterial skin and skin-structure infections (ABSSSIs)** as erysipelas, cellulitis, major abscesses, and **surgical-site infections (SSIs)**
- Various other classification systems have been proposed:
 - Eron et al (2003) – by severity of local and systemic signs, and presence (or absence) of comorbidities
 - IDSA (2014) – by purulence, severity (mild, moderate, and severe), and tissue necrosis
 - WSES (2015) – as SSIs, non-necrotizing SSTIs, and necrotizing SSTIs

Stevens (2014), Chahine (2015), Sartelli (2018)

Microbiology

- **Skin's defenses** against pathogenic colonization: physical barrier, low pH, bacteriostatic sebaceous fluid, normal skin flora
- Organisms that colonize the skin **above the waist** tend to be **aerobic gram-positive cocci**
- **Below the waist, both gram-positive and gram-negative species** are present (potentially due to anorectal region)
- Axillae, groin, and other intertriginous areas have higher moisture and larger populations of bacteria
- Microflora tend to reside in upper parts of hair follicles and outer layer of skin (stratum corneum)



Ki (2008)



Staph and Strep

- *Methicillin-resistant Staphylococcus aureus* (MRSA) and Group A beta-hemolytic streptococci (GAS) are the predominant organisms in SSTIs
 - Considerable variation in resistance rates of *S aureus* to methicillin (or oxacillin):
 - Highest rates in North America (35.9%), Latin America (29.4%), and Europe (22.8%)
 - MSSA/MRSA and GAS produce toxins that potentiate their virulence



History of Present Illness

- Specific exposures (e.g., salt water, cat bite)
- Type of wound (e.g., puncture, laceration, excoriation)
- Impairment of healing (e.g., diabetes, chronic immunosuppressive therapy including steroid use, recent surgery)

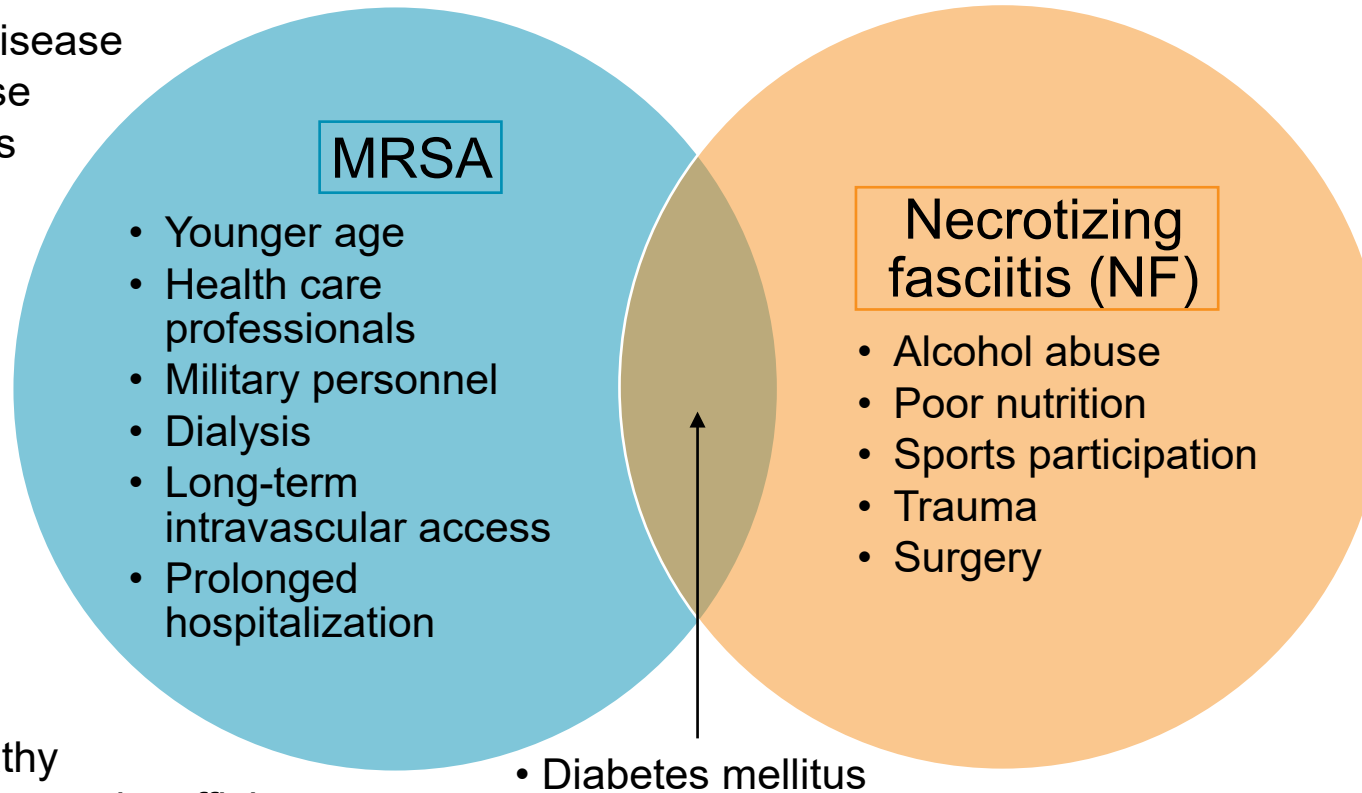


Rajan (2012), Ramakrishnan (2015)

Risk Factors

- Cardiopulmonary disease
- Hepatorenal disease
- Human/animal bites
- Older age
- Asplenia
- Debility
- Obesity

- IV/SC drug use
- Water exposure
- Lymphedema
- Peripheral neuropathy
- Peripheral arteriovenous insufficiency
- Immunocompromise (e.g., HIV, chemotherapy)



Ki (2008), Ramakrishnan (2015), Sartelli (2018), Stevens (2014), Chahine (2015)



Physical Exam

- Minimal diagnostic criteria = “typical inflammatory tetrad”
 - Warmth, erythema, tenderness, swelling
 - Pain and swelling → loss of function of the affected body part
 - Possible secretion or purulent discharge
- Signs and symptoms of a more severe infection:
 - Pain out of proportion (may reflect tissue ischemia)
 - ≥2 SIRS criteria (fever, tachycardia, tachypnea, leukocytosis)
 - Hypotension
 - Purpura, crepitus, tissue necrosis
 - Lymphangitic spread

INFLAMMATION



CALOR

RUBOR

TUMOR

DOLOR

FUNCTIO
LAESA



Sick or Not Sick?



Mild

- Local symptoms only

Moderate/Severe

- Systemic signs of infection (e.g., fever, tachycardia, tachypnea, leukocytosis)



Diagnostic Modalities

- **Diagnosis of SSTIs is predominantly clinical**
- In general, imaging is not indicated for simple SSTIs
 - Utility of XRs limited, but can reveal gas and periosteal inflammation; CT/MRI can image fascial planes and may be useful for deeper infections, but practicality is limited
 - US may be used to evaluate extent and depth of infection in children
- Similarly, “routine” lab studies (e.g., CBC, CRP) and blood cultures are typically not necessary for well-appearing, ambulatory patients
- Consider gram-stain and wound culture if antibiotics will be given for an abscess (or for recurrent abscess)



Principles of Treatment

*Furuncles
(boils)
Carbuncles
(cluster of boils)
Abscesses*

Purulent

Mild:

- Incision and drainage (I&D)

Moderate/severe:

- I&D
- Antibiotics (cover MRSA)
- Surgical debridement

Non-purulent

Mild:

- Topical antibiotics

Moderate:

- Oral antibiotics (cover GAS)

Severe:

- Parenteral antibiotics
- Surgical debridement

*Erysipelas
Cellulitis
Necrotizing fasciitis*

Rajan (2012), Chahine (2015), Ramakrishnan (2015)



Antibiotic Selection

- Societal guidelines based on retrospective data, clinical experience, and expert opinion
 - **Local antibiograms** (antimicrobial susceptibility) may be helpful
 - Recommendations based on specific bacterial etiology are difficult to apply clinically
- Purulent (suspect MRSA): clindamycin (consider TMP-SMX or doxycycline)
 - If MSSA, could also consider cephalexin or amoxicillin-clavulanate
- Non-purulent (suspect GAS): cephalexin (consider clindamycin)



Duration of Treatment

- A 5 day course of antibiotics may be as efficacious as 7-14 days
- An appropriately-treated SSTI should show **no further spread within 48-72 hours of antibiotic administration**
- **Reassess diagnosis and treatment if not improving within 5 days**

QUINOLONES
CARBAPENEMS
CEPHALOSPORINS
TETRACYCLINES
MACROLIDES
LINCOMYCINS
SULFONAMIDES
PENICILLINS
AMINOGLYCOSIDES
GLYCOPEPTIDES

Stevens (2014), Ramakrishnan (2015), Sartelli (2018), Children's Minnesota

Hospitalization

- Indications for in-patient management:
 - Failed outpatient treatment
 - Can't tolerate oral antibiotics
 - Severe/complicated infection (e.g., NSTI)
 - Unstable comorbidities
 - Signs of sepsis
 - Need for surgical intervention under anesthesia



Ramakrishnan (2015)



SSTIs in a Nutshell

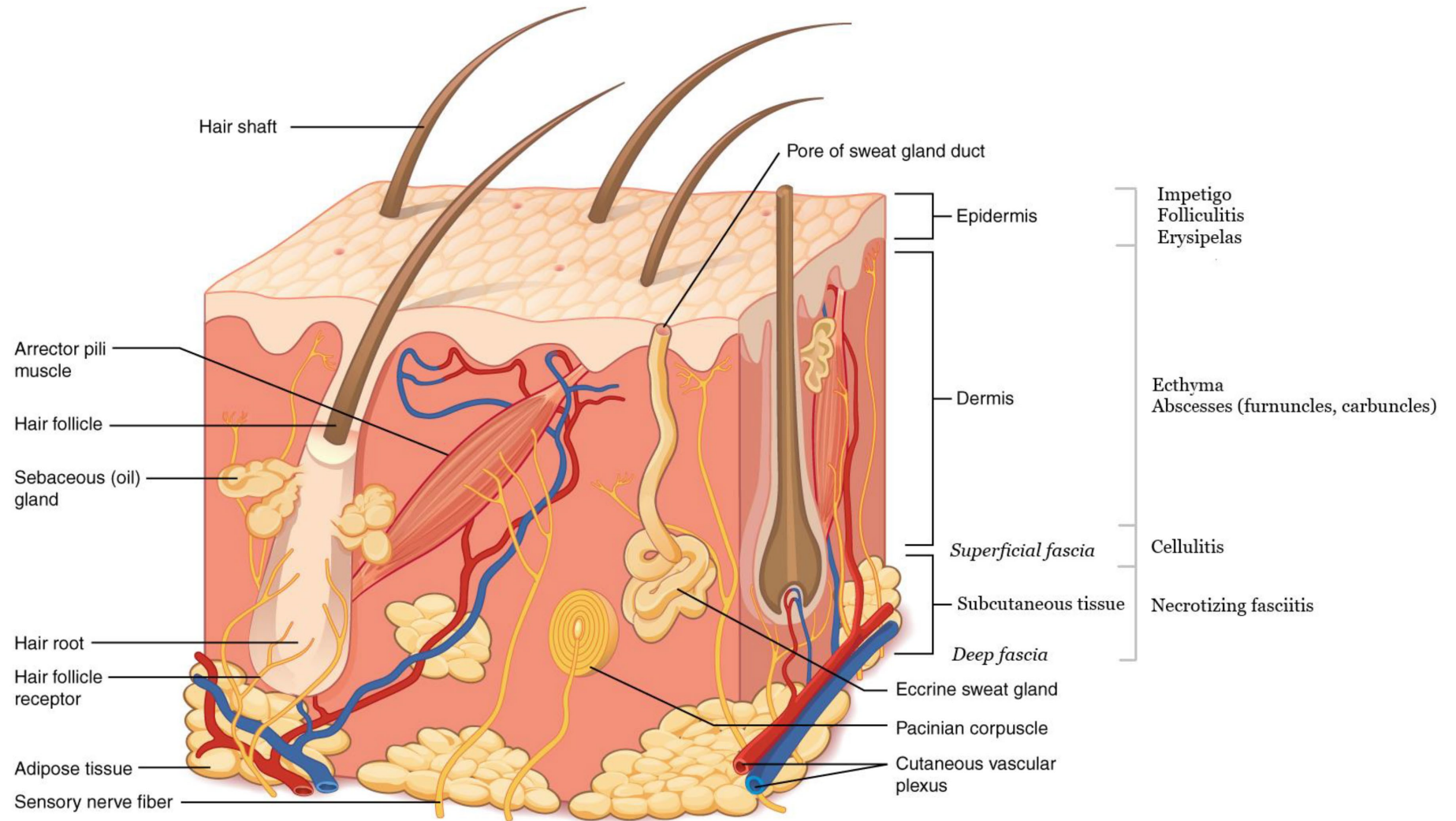
- SSTIs are a heterogeneous group, so consider:
 1. Condition of patient (septic or non-toxic, co-morbidities, etc.)
 2. Anatomical extension (depth and bodily location)
 3. Characteristics of infection (purulent or non-purulent)
 4. Evidence of tissue necrosis
- Diagnosis usually based on clinical impression
- Management determined by severity and location of infection, and patient co-morbidities
 - Initial antibiotic choice is usually empiric

Ki (2008), Ramakrishnan (2015), Sartelli (2018)



Diagnosis and Treatment of Specific SSTIs

SSTIs by Depth



Silverberg (2021)

Impetigo

- Erythematous, pruritic rash on face/extremities featuring small, fluid-filled vesicles
 - May turn into pustules or bullae and usually leave brown or **golden, honey-colored crusts**
 - Can use warm water soaks to help remove crusts
- Initial treatment is with **topical mupirocin** or retapamulin ointment x5+ days
- If widespread infection or household outbreak, use oral **cephalexin** (clindamycin and TMP-SMX can be considered if treatment failure) x5 days



Stevens (2014), Chahine (2015), UCSF

Ecthyma

- Deep form of impetigo (i.e., usually *Streptococcus* spp.)
 - Ulcerative pyoderma
- Typically, a topical antibiotic is insufficient
 - If *Streptococcus* spp.: PCN VK
 - If MSSA: dicloxacillin, cephalexin
 - If MRSA: clindamycin, doxycycline, SMX-TMP
- Treat x7+ days
- Consider debriding crusts



Dermatology Advisor

Stevens (2014), Chahine (2015)

Folliculitis

- Infection of ≥ 1 hair follicles (i.e., doesn't affect palms/soles)
 - Erythematous, papular/pustular, pruritic rash
 - Usually the pustule has a hair emerging from it
- Often caused by **MRSA**, but “hot tub” folliculitis associated with *Pseudomonas aeruginosa*
- Differential diagnosis includes fungal and viral infections (e.g., *Pityrosporum* folliculitis, herpes gladiatorum)
- Treatment includes antibacterial soap and good hygiene; warm, moist compresses; and topical and/or oral antibiotics
 - Avoid shaving affected area until infection resolves





Abscesses

- Furuncles (boils) are usually deeper and more painful than folliculitis
- Carbuncles (cluster of boils) are even larger, drain pus, and often have other symptoms (e.g., fever, fatigue, lymphadenopathy)
- Consider **warm compresses** or soaks for small (<1-2cm) superficial abscesses
- **Incision and drainage (I&D) alone should be sufficient intervention if the abscess is in an easily-accessible region without significant overlying cellulitis**
 - Wound packing vs. wick or drain placement
- If SIRS criteria (i.e., altered temperature, tachypnea, tachycardia, leukocytosis/leukocytopenia), add coverage against MRSA

Stevens (2014), Chahine (2015), Ramakrishnan (2015), Sartelli (2018), Children's Minnesota



Abscesses (*con't*)

- **Paronychia** can be relieved with an #11 blade along the nail gutter
- **Dental abscesses** can be difficult to drain in a medical clinic; antiseptic mouth rinses and oral antibiotics may be more appropriate until definitive treatment by a dentist
- **Hidradenitis suppurativa** is a chronic, painful, suppurative infection of the sweat glands in the axillae and/or groin; *avoid I&D*
- Pilonidal sinus → cyst → abscess
- Complicated abscesses (e.g., injection drug sites, perineal region) are polymicrobial but still usually respond to I&D
 - Large abscesses should be drained with multiple counter incisions



Recurrent Abscesses

- ≥ 3 occurrences per year
- Consider local causes (e.g., pilonidal cyst, hidradenitis suppurativa, retained foreign material)
- Recurrent abscesses should be drained and cultured
- Treatment includes 5-10 day course of appropriate antimicrobials and possible **5+ day decolonization regimen**:
 - Intranasal mupirocin 2% ointment BID
 - Chlorhexidine 4% washes daily (or BIW dilute bleach baths)
 - Daily decontamination of personal items (e.g., towels, sheets, clothing)

Stevens (2014), Chahine (2015), UCSF, Sartelli (2022)



Human and Animal Bites

- What is the medical history of the biter?
 - Post-exposure (PEP) rabies prophylaxis
 - Tetanus toxoid booster (TdaP preferred over Td)
 - Human bites can also transmit HBV, HCV, and HIV (also consider PEP)
- Signs of infection may have delayed presentation (24-72 hours after injury)
- Infections in damaged skin (e.g., bites, burns, pressure ulcers) usually require irrigation and debridement but **antibiotic prophylaxis generally not recommended (exception: hands)**
 - In general, 10-20% of bite wounds become infected
 - 30-50% of cat bites, 5-25% of dog bites, 20-25% of human bites

Stevens (2014), Chahine (2015), Sartelli (2018), Sartelli (2022)



Bites (*con't*)

- If immunocompromised, asplenic, or moderate/severe injuries (injury to the hands/face or periosteum/joint capsule), give antibiotics active against aerobic and anaerobic bacteria
 - If bone/joint involved, assess for septic arthritis and osteomyelitis
 - Human bite wounds (e.g., “fight bite”): 50% *Streptococci* spp., 40% *S aureus*, 30% *Eikenella corrodens*
 - Amoxicillin-clavulanate PO, ceftriaxone IM + metronidazole PO (if PCN allergy, TMP-SMX PO + clindamycin PO)
- Irrigate wound; avoid primary closure (exception: the face)

Stevens (2014), Chahine (2015), Sartelli (2018)

Cellulitis

- (It's never a) “spider bite”
- Diffuse, acute inflammation and infection of the dermis and subcutaneous tissue, usually of the lower extremities
 - May invade lymph tissue and blood
- Can mask necrotizing fasciitis, septic joints, or osteomyelitis (i.e., **can actually be a symptom rather than primary diagnosis!**)
- Swabs, cultures, and biopsies not routinely recommended
- Consider complicating factors (e.g., IVDU, penetrating trauma)





Cellulitis (*con't*)

- 5 day course of antibiotics may be as effective as 10 days' worth
 - That said, if not improving within 48 hours of starting treatment, expand coverage and pursue imaging
- Elevate affected area to facilitate drainage
- Treat predisposing factors (e.g., edema, venous insufficiency)
- Examine interdigital toe spaces for fissuring or maceration
- Ludwig's angina (cellulitis of the submandibular region) or orbital cellulitis warrant aggressive antibiotic treatment and potentially surgical intervention

Stevens (2014), Ramakrishnan (2015), Chahine (2015), Brindle (2019), Sartelli (2022)



Recurrent Cellulitis

- Identify and treat predisposing conditions (e.g., eczema, obesity)
- If ≥ 3 -4 episodes of cellulitis annually despite attempts to treat/control predisposing factors, consider **antibiotic prophylaxis** with PCN VK or erythromycin PO BID x4-52 weeks (or PCN G IM q2-4 weeks)



Stevens (2014), Chahine (2015)

Erysipelas

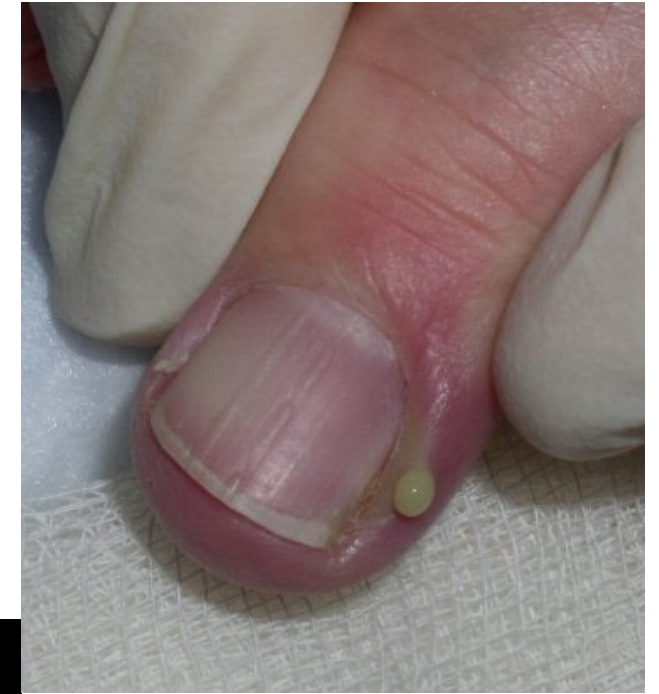
- Erysipelas is a more superficial form of cellulitis, but skin lesion is actually raised above the level of the surrounding skin
 - Clear demarcation between affected and uninvolved tissue
 - More often affects infants and the elderly
 - Typically caused by *S pyogenes*; role of MRSA unclear
 - “St. Anthony’s fire”
- Cellulitis and erysipelas may be treated with PO/IV antibiotics, corticosteroids/NSAIDs, and surgical intervention (if purulent)



Chahine (2015), Sartelli (2022)

Other Specific Infections

- Infections of the fingers
 - Ingrown nail
 - Paronychia
 - Felon
 - Herpetic whitlow
- Other viral infections
 - VZV → Shingles
 - HSV →
 - Herpes genitalium
 - Herpes labialis
 - Herpes gladiatorum



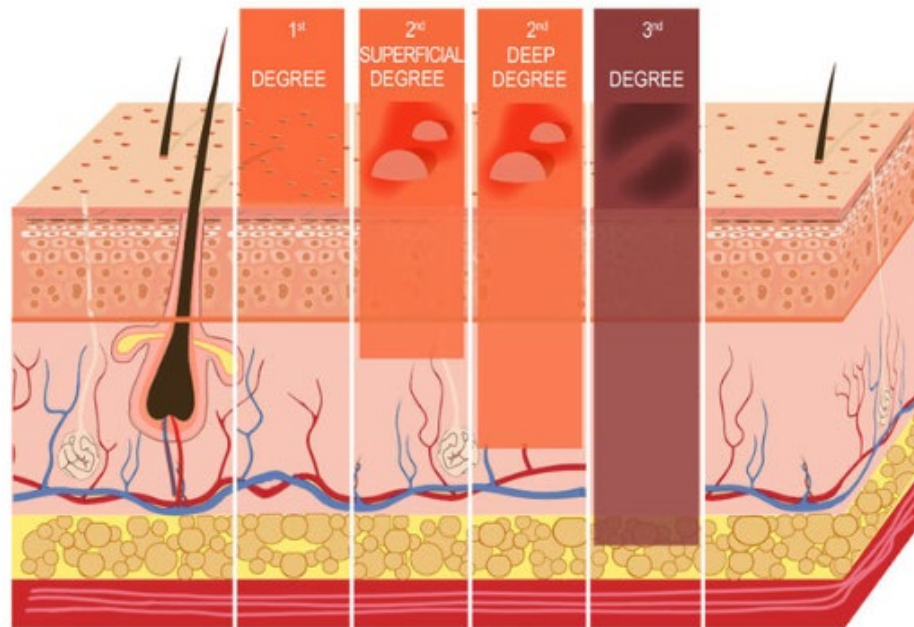


Thermal Burns

- Sterile immediately after thermal injury, but quickly colonized with microorganisms thereafter
 - Endogenous gram-positive environmental and skin flora
 - Gram-negative colonization within a week of injury
 - Wound cultures may be helpful in targeting treatment
 - Most septic events occur within the first two weeks after injury
- **Topical antibiotics** and wound dressings commonly-used, but no specific guidelines regarding systemic antibiotic prophylaxis
 - In animal models, 1% silver sulfadiazine (SSD) may impair wound healing

Thermal Burns (*con't*)

- “Rule of nines” tends to overestimate burn size (%TBSA)
 - Lund-Browder chart takes patient age into account
- Newer classification system focuses on affected tissue layer(s)

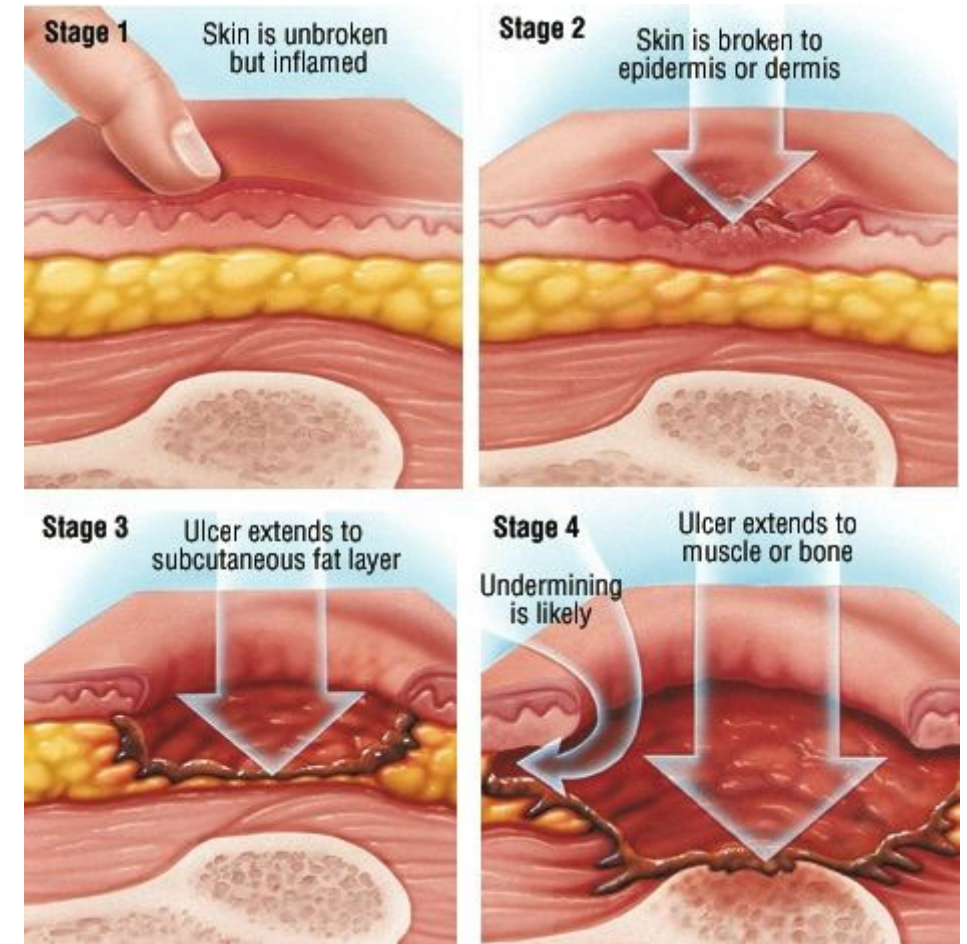


Depth	Degree
Superficial	First-degree
Superficial partial thickness	Second-degree
Deep partial thickness	
Full-thickness	Third-degree
Deep full-thickness	Fourth-degree
	Fifth-degree
	Sixth-degree

Sartelli (2018)

Pressure Ulcers

- Localized areas of tissue necrosis due to soft tissue being compressed between bony prominence and external surface for a prolonged period
- Typically polymicrobial
 - *S aureus*, *Enterococcus* spp., *Proteus mirabilis*, *Pseudomonas* spp.
 - *Peptococcus* spp, *Bacteroides fragilis*, *Clostridium perfringens*
- Surgical debridement usually necessary to remove necrotic tissue





Surgical-Site Infections

- If high risk of post-operative SSI (e.g., implantation of foreign materials such as mesh or joint prosthesis), antibiotic prophylaxis should be given before and during surgery only (i.e., not afterwards)
- SSIs usually occur >4 days after the operation
 - Can be superficial incisional, deep incisional, or organ/space
 - Superficial incisional most common type of SSI, but deep incisional and organ/space SSIs cause the most morbidity
- *Diagnosis is clinical*
 - Consider risk factors for MRSA and, separately, integrity of host defenses
- Treatment includes prompt, wide opening of the surgical incision
 - Antibiotics indicated if significant systemic response

Stevens (2014), Chahine (2015), Sartelli (2018)



Necrotizing Infections

- Necrotizing soft-tissue infections (NSTIs) are life-threatening, invasive, and can involve any and all layers of soft tissue
 - May be mono-microbial or polymicrobial; may also be described by anatomic region (e.g., Fournier's gangrene) or depth (e.g., necrotizing myositis)
 - Rapidly-progressing
 - 20-30% of patients with an NSTI die during their hospital stay
- Diagnosis is clinical, but can be difficult to distinguish from cellulitis at first (worrisome local signs include pain out-of-proportion, bullae, crepitus; systemic signs include tachycardia, hypotension, shock)
- Laboratory tests neither highly sensitive nor specific, but blood cultures should be drawn

Chahine (2015), Sartelli (2018), Sartelli (2022)



NSTIs (*con't*)

- Imaging should not delay surgical consultation and intervention
- **Surgical source control should be within the first 12 hours**
 - *Source control is the most important determinant of outcome in NSTIs*
 - Wound should be left open
- No clear evidence about optimal duration of antibiotic treatment for NSTIs (basically, administer antibiotics until no further debridement needed, patient has improved clinically, and fever has resolved for >48-72 hours)
- Post-operative treatment requires a multidisciplinary approach: wound care, surgical reconstruction, rehabilitation, etc.

Ramakrishnan (2015), Sartelli (2018), Sartelli (2022)



Adjuvant Therapies

- **Oral steroids** (e.g., prednisone 40mg PO daily x7 days) may be considered in non-diabetic adults with severe cellulitis
- **Hyperbaric oxygen (HBO) therapy** *not* recommended for NF because it has not been proven to yield benefit (and it may delay resuscitation and surgical debridement)
- **Intravenous immunoglobulin (IVIG)** offers *no* clear benefit
- **Negative-pressure wound therapy (NPWT)** devices (consisting of a vacuum pump, drainage tubing, and wound dressing) may promote wound healing

Rajan (2012), Stevens (2014), Chahine (2015), Sartelli (2018)



Practice Points

- **Systemic signs** (e.g., fever, hypotension, tachycardia) suggest a more severe infection: *trust your gut*.
- Abscesses can typically be treated with **I&D** alone.
- Unless the hands are involved, **antibiotic prophylaxis** generally not recommended for bite wounds.
- For cellulitis, a **shorter course** of antibiotics may be sufficient.
- **Surgical intervention** for NSTIs should be **within the first 12 hours** of hospital admission.





Recommended Readings

- Children's Minnesota, SSTI clinical guidelines (revised 2021 Apr) – found at:
<https://www.childrensmn.org/references/cds/skin-and-soft-tissue-guideline.pdf>
- Kamath RS, et al. Guidelines vs Actual Management of Skin and Soft Tissue Infections in the Emergency Department. *Open Forum Infectious Dis*, 2018 Jan; 5(1): ofx188.
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Other References

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Self-Assessment Questions



Comprehension Question #1

- ***Named after Saint Anthony (the patron saint of lost causes), this “hot” infection affects which part of the body?***
 - a) Epidermis
 - b) Subcutaneous fat
 - c) Muscle
 - d) Bone
 - e) Urethra





Comprehension Question #2

- ***Which of the following conditions is most appropriate for incision and drainage (I&D) in an outpatient office setting?***
 - a) *Pityrosporum* folliculitis
 - b) Pilonidal abscess
 - c) Periodontal infection
 - d) Bullous pemphigoid
 - e) Pyomyositis





Comprehension Question #3

- ***Which of the following medications would be an appropriate first-line treatment for ecthyma?***
 - a) Mupirocin
 - b) Prednisolone
 - c) Clindamycin
 - d) Rifampin
 - e) Reltecimod





Comprehension Question #4

- ***The single most important intervention for necrotizing fasciitis (NF) is...***
 - a) Early surgical debridement
 - b) Antibiotics active against *Pseudomonas* spp.
 - c) Elevation of the affected body part
 - d) Hyperbaric oxygen (HBO) therapy
 - e) Targeted temperature management (therapeutic hypothermia)





Comprehension Question #5

- ***A 39 year-old man presents to your clinic with concern for a “spider bite,” though he never actually saw the arachnid. Which of the following signs is most likely to indicate a serious SSTI?***
 - a) Localized warmth
 - b) Poorly-circumscribed erythema
 - c) Swelling of the affected body part
 - d) Pain out of proportion
 - e) Fluctuance of the wound

