



Skin and Soft Tissue Infections

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Disclosures of Financial Relationships with Relevant Commercial Interests

- Editor: ID Clinics of North America, Sanford Guide

Question #1

A 25-year-old female suffers a cat bite on the forearm.
She presents one hour later for care.

If no antibacterial is administered, what is the percentage of such patients that get infected?

- A. 0-10 %
- B. 10-30 %
- C. 30-70 %
- D. 70-100 %

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- C. 30-70 %* up to 50% of cat bites become infected***
- D. 70-100 %

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Management of Animal Bites

- Wound care: irrigation, debridement
- Image for fracture or as baseline for osteomyelitis or to detect foreign body?
- Wound closure: NO
- Anticipatory (prophylactic) antibiotics
- Vaccines (tetanus and rabies)

Cat Bites

- 30-50% cat bites become infected with bacteria
- Wound types: puncture
- Microbiology: 63% polymicrobial
- Infection type:
 - Nonpurulent wound with cellulitis, lymphangitis, or both (42%)
 - Purulent wound without abscess (39%)
 - Abscesses (19%)

Bacterial genus	Frequency (%)
Aerobic organisms	
<i>Pasteurella</i>	75
<i>Streptococcus</i>	46
<i>Staphylococcus</i>	35
<i>Neisseria</i> ²	35
<i>Moraxella</i>	35
<i>Corynebacterium</i>	28
<i>Enterococcus</i>	12
<i>Bacillus</i>	11
Anaerobic organisms	
<i>Fusobacterium</i>	33
<i>Porphyromonas</i>	30
<i>Bacteroides</i>	28

Abrahamian FM1, Goldstein EJ. Microbiology of animal bite wound infections. Clin Microbiol Rev. 2011 Apr;24(2):231-46. doi: 10.1128/CMR.00041-10. NEJM 1999; 340: 85-92.

Pasteurella multocida

- In saliva of > 90% of cats and over 50% of wounds get infected
- Different species, *Pasteurella canis*, in saliva of 50% of dogs and only 2-10% get infected
- Small aerobic gram-negative bacillus
- Hard to remember antibiotic susceptibility profile, but amoxicillin sensitive; alternatives can be tricky

Six Pathogens That Can Cause Infection After Cat Bites

- *Pasteurella species*
- Anaerobic bacteria: e.g., *Fusobacteria*
- *Bartonella henselae* (Cat Scratch disease)
- Rabies virus
- *S. aureus*
- Streptococcal species

Question #2

A 50-year-old female with alcohol substance use disorder suffered a provoked dog bite

- Bite was cleansed, tetanus toxoid given, and the dog placed under observation
- **Patient is post-elective splenectomy for ITP; she received pneumococcal vaccine one year ago**
- One day later, the patient is admitted to the ICU in septic shock with severe DIC and peripheral symmetric gangrene of the tips of her fingers/toes

Question #2

Which one of the following is the most likely etiologic bacteria?

- A. *Pasteurella canis*
- B. *Capnocytophaga canimorsus*
- C. *Fusobacterium spp.*
- D. *Bartonella henselae*

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- D. *Bartonella henselae*

Dog Bites and Splenectomy

- Only 2-10% of dog bites get infected
- Potential pathogens from
 - Dog's mouth:
 - *Pasteurella canis*, *Capnocytophaga canimorsus*
 - Human skin: *S. aureus*, *S. pyogenes*
- *Capnocytophaga* is an important cause of overwhelming sepsis in splenectomized patients
- *Capnocytophaga spp.*
 - Susceptible to: amox/clav, pip/tazo, penicillin G, and clindamycin
 - Resistant to: TMP/SMX and maybe vancomycin

Question #3

A 45-year-old USA male experiencing homelessness presents with fever and severe polymyalgia

- On physical exam, **animal bite marks found around his left ankle. A faint rash is visible on his extremities.**
- Within 24 hours, blood cultures are positive for pleomorphic gram-negative bacilli.

Which one of the following is the most likely diagnosis?

- A. *Pasteurella multocida*
- B. *Haemophilus parainfluenza*
- C. *Spirillum minus*
- D. *Streptobacillus moniliformis*

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Rat Bite Fever

- USA: *Streptobacillus moniliformis*
- Asia: *Spirillum minus*
- Bites or contaminated food/water
- *S. moniliformis*:
 - Fever, extremity rash
 - Macular/papular, pustular, petechial, purpuric
 - Symmetrical polyarthralgia
- Treatment: penicillin or doxycycline



Question #4

A 35-year-old male suffers a clenched fist injury in a barroom brawl.

- He presents 18 hours later with fever and a tender, red, warm fist wound
- Gram stain of bloody exudate shows a small gram-negative rod with some coccobacillary forms
- The aerobic culture is positive for viridans streptococci

Which one of the following organisms is the likely etiologic agent?

- A. *Viridans streptococci*
- B. *Eikenella corrodens*
- C. *Peptostreptococcus*
- D. *Fusobacterium species*

Talan, D. CID 2003; 37: 1481

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Eikenella corrodens

- Anaerobic small gram-negative bacillus
- Susceptible to:
 - Penicillins, fluoroquinolones, doxycycline, and extended spectrum cephalosporins (ceftriaxone, ceftazidime)
- Resistant to:
 - Cephalexin/cefazolin, clindamycin, erythromycin, diclox/oxacillin, metronidazole, and TMP/SMX

Question #5 Extra Credit

Medicinal leeches are applied to a non-healing leg ulcer.

Which one of the following pathogens is found in the “mouth” of the leech?

- A. *Alcaligenes xylosoxidans*
- B. *Aeromonas hydrophila*
- C. *Acinetobacter baumannii*
- D. *Arcanobacterium haemolyticum*

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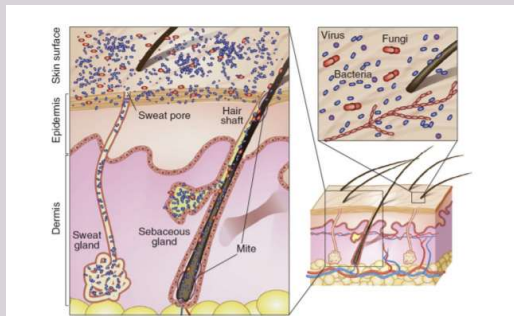
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Aeromonas spp.

- *Aeromonas spp.* - aerobic gram-negative bacilli
 - *Aeromonas hydrophila* (most common)
 - *Aeromonas veronii*
 - *Aeromonas shubertii*
- Cause gastroenteritis (most common), wound infection (following trauma/exposure to leeches) or bacteremia after exposure to *Aeromonas* species in fresh, brackish, or marine water
- Variable antimicrobial susceptibility; need culture and susceptibility testing of infected wound, stool, and blood
 - Resistance to beta-lactams and fluoroquinolones in selected areas of the world
 - **Uniformly resistant to ampicillin, penicillin, and cefazolin**

The Skin: Local Invasion by Structure



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Skin Infections: Predisposing Factors

- Trauma to normal skin
- Immune deficiency
- Disrupted venous or lymphatic drainage
- Local inflammatory disorder
- Presence of foreign body
- Vascular insufficiency
- Obesity; poor hygiene

***S. aureus* Skin Infection**

Predisposing Factors

Risk Factors Associated with MRSA SSTI

- Ethnicity (African American, Hispanic compared with Caucasian)
- Socioeconomic lower quintile
- Previous colonization or *S. aureus* infection
- Exposure: hospital, long-term care facility, household contacts
- Contact activities - daycare children, contact sports, military
- Comorbidities: diabetes, peripheral vascular disease, cardiovascular disease, chronic wounds
- Chronic kidney disease, dialysis dependence, intravenous drug use
- Pre-existing skin lesions (burns, eczematous dermatitis, etc.)
- Hereditary or iatrogenic neutrophil disorders

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What Is This?



Superficial Folliculitis

- **Purulence (sometimes mixed with blood) where hair follicles exit skin**
- Etiology:
 - *S. aureus*
 - *P. aeruginosa* (hot tub)
 - *C. albicans* (esp. in obese patient)
 - *Malassezia furfur* - lipophilic yeast (former *Pityrosporum sp*)
 - Idiopathic eosinophilic pustular folliculitis in AIDS patients

Folliculitis under the swim trunks is?



**Folliculitis under the
swim trunks is
*Pseudomonas***



**Microbial
Etiology?**

“Honey Crust”



**Streptococcal Infection of the Epidermis
Name of the Clinical Syndrome?**

- Infection of outer layers of epidermis with production of “honey-crust” scales
- Prevalent in warm, humid environments – esp. in children.
- Microbial etiology
 - Streptococci: Groups A, B, C, G
- **Name?**
 - **Streptococcal impetigo**

**Fragile
Superficial
Bullae**



Fragile Bullae in Epidermis

Diagnosis?

- Bullous impetigo

Etiology?

- *S. aureus*

Impetigo (“To Attack”)

- Bullous impetigo: *S. aureus*
- Non-bullous impetigo: *S. pyogenes*, group A
- So, empiric therapy aimed at *S. aureus* as could be MRSA
- Topical: topical antibiotic ointment (TAO), mupirocin, retapamulin
- **Oral rarely needed**
 - e.g., clindamycin, doxycycline

Complications of *S.pyogenes*, *S. dysgalactiae* (Groups C&G) Impetigo

- Post-streptococcal glomerulonephritis due to nephritogenic strains
- Rheumatic fever has “never” occurred after streptococcal impetigo





- Acute onset of painful, rapidly spreading red plaque of inflammation involving epidermis, dermis, and subcutaneous fat
- NO PURULENCE

Diagnosis?

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Diagnosis:

- **Erysipelas: Non-purulent cellulitis**

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Diagnosis:

- Erysipelas: Non-purulent cellulitis

Etiology?

- Acute onset of painful, rapidly spreading red plaque of inflammation involving epidermis, dermis, and subcutaneous fat
- NO PURULENCE

Diagnosis:

- Erysipelas: Non-purulent cellulitis

Etiology:

- **Hemolytic Streptococci: Group A**
 - Now less common than groups C and G
- If on the face, could be *S. aureus*



Erysipelas (“Red Skin”)

- Acute onset of painful skin, rapid progression +/- lymphangitis
- Inflamed skin elevated, red, and demarcated
- Etiology: Streptococci--Groups A,B,C, & G (*S. pyogenes*, *S. agalactiae*, *S. dysgalactiae subsp. equisimilis*)
- Predisposition:
 - Lymphatic disruption, venous stasis

Erysipelas and Cultures

- Most often, no culture necessary
- Can isolate *S. pyogenes* from fungal-infected skin between toes
- Low density of organisms
 - Punch biopsy positive in only 20-30%
- Blood cultures positive in $\leq 5\%$
- Confused with stasis dermatitis

Stasis Dermatitis



Stasis Dermatitis

- Looks like erysipelas; more frequent in obese individuals
- **No fever**
- Chronic, often **bilateral**, dependent edema
- Goes away with elevation
- **Does not respond to antimicrobials**
- **Cadexomer iodine (IODOSORB) response rate 21% vs 5% for usual care**

Treatment of Erysipelas (Non-purulent “cellulitis”)

- Elevation
- Topical antifungals between toes if tinea pedis present
- Penicillin, cephalosporins, clindamycin, TMP/SMX
- Avoid macrolides due to frequency of resistance

Cellulitis



Without localization or preceding macro or micro trauma:
usually Beta Strep. (usually GAS), extremities > face, elsewhere
With localization (cut, pustule, etc.) or preceding trauma: *S. aureus*

Severe Cellulitis



Microbiology: Streptococci (group A>B,C,G); less often *S. aureus*; rarely GNR

Recurrent Cellulitis

- Frequently non-group A streptococci (esp. B, G)
- Relapse > recurrence
- Prophylaxis:
 - Benzathine penicillin IM
 - Oral penicillin; other systemic antibiotics
 - Decolonization (nasal, elsewhere)

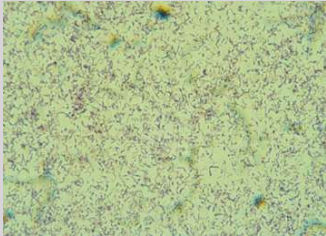
Risk Factors for Recurrent Erysipelas

- Lower Extremity
 - Post-bypass venectomy
 - Chronic lymphedema
 - Pelvic surgery
 - Lymphadenectomy
 - Pelvic irradiation
 - Chronic dermatophytosis
- Upper Extremity
 - Post-mastectomy/node dissection
- Breast
 - Post-breast conservation surgery, biopsy

Erysipelothrix (Gram + Rod)

- On finger after cut/abrasion exposure to infected animal (swine) or fish
- **Subacute erysipelas (erysipeloid)**
- Severe throbbing pain
- **Diagnosis: Culture of deep dermis (aspirate or biopsy)**
- Treatment: Penicillin, cephalosporins, clindamycin, fluoroquinolone

Erysipelothrix rhusiopathiae Infection



Gram stain of the organism (G+ rod) identified on culture



Resolving cellulitis caused by *Erysipelothrix rhusiopathiae*

Question #6

A 53-year-old male construction worker has sudden onset of pain in his left calf.

- Within hours the skin and subcutaneous tissue of the calf are red, edematous and tender. Red “streaks” are seen spreading proximally
- A short time later, patient is brought to the ER confused, vomiting, and hypotensive
- Temp 40C, diffuse erythema of the skin. Oxygen sat. 88% RA
- WBC 3000 with 25% polys and 50% band forms; platelet count is 60,000; creatinine 3.2mg/dl

Question #6

Which one of the following is the most likely complication of the erysipelas?

- A. Bacteremic shock due to *S. pyogenes*
- B. Toxic shock due to *S. pyogenes*
- C. Bacteremic shock due to *S. aureus*
- D. Toxic shock due to *S. aureus*

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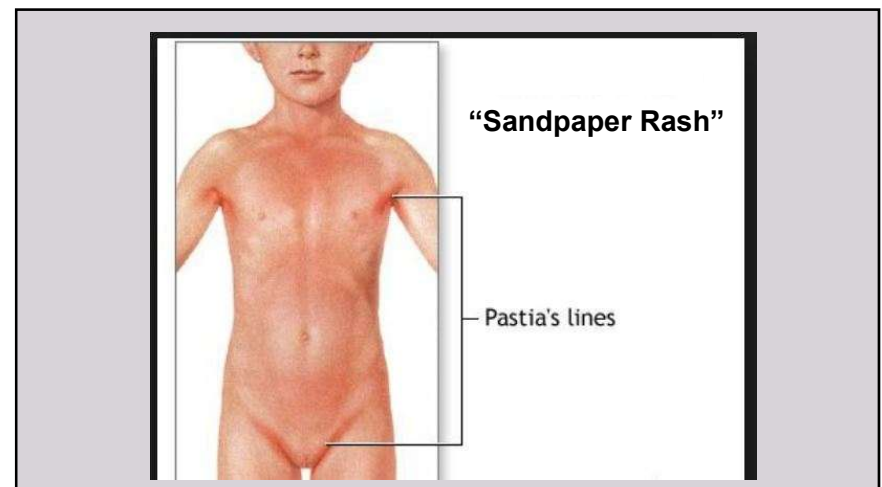
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- B. Toxic shock due to *S. pyogenes****
- C. Bacteremic shock due to *S. aureus*
- D. Toxic shock due to *S. aureus*

Toxic Shock Syn. (TSS): Staph vs Strep

Feature	Staphylococcal	Streptococcal
Predisposition	Tampon, surgery; colonization	Cuts, Burns, Varicella, erysipelas
Focal Pain	No	Yes
Tissue necrosis/inflammation	Rare	Common
N/V, renal failure/DIC	Yes	Yes
Erythroderma	Very common	Less Common
Bacteremia	Very rare (5%)	60%
Mortality	<6%	30-70%

Sore Throat and Skin Rash

- 20-year-old male with 3 days of sore throat, fever, chills, and skin rash
- Rash is nonpruritic and involves abdomen, chest, back, arms, and legs
- Exam: exudative tonsillitis, strawberry tongue, rash, and tender cervical lymph nodes



Case Study

Which is the most likely diagnosis?

- A. Infectious mononucleosis
- B. Coxsackie hand, foot and mouth disease
- C. Scarlet fever
- D. *Arcanobacterium hemolyticum*

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Question #7

- 18-year-old male taking anti-seizure meds for idiopathic epilepsy develops fluctuant tender furuncle on right arm
- He develops fever and generalized erythroderma
- Wherever he is touched, a bullous lesion develops
- **Skin biopsy shows intra-epidermal split in the skin**

Question #7

Which one of the following is the likely etiology of the skin bullae?

- A. *S. aureus* scalded skin syndrome
- B. Bullous pemphigus
- C. Drug-induced Toxic epidermal necrolysis (TEN)
- D. *S. pyogenes* necrotizing fasciitis

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Nikolsky sign



Exfoliative Toxins cause
Epidermal split
• Stratum granulosum

The Skin and Toxins of *S. aureus* and *S. pyogenes*

Organism	Toxin	Clinical Diagnosis
<i>S. aureus</i> colonization	TSST	TSS & Erythroderma
<i>S. aureus</i> colonization	Exfoliative toxin	Impetigo; scalded skin syndrome
<i>Strep. pyogenes</i> invasion	TSST	TSS; Erythroderma (not always)
<i>Strep. pyogenes</i>	Pyrogenic exotoxin	Pharyngitis; Scarlet Fever (sandpaper rash)



Case Study

Erysipelas with Loss of Pain, Hemorrhagic Bullae, Rapid Progression...

Necrotizing fasciitis is due to which one?

- Streptococcal fasciitis
- Staphylococcal fasciitis
- Clostridial infection
- Synergy between aerobe (*S. aureus*, *E. coli*) plus anaerobe (anaerobic strep, *Bacteroides sp*) equals Meleney's, Fournier's

Lancet ID 2015;15:109

Case Study

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Necrotizing Fasciitis: At The Bedside



- Sudden onset excruciating pain & systemic toxicity
- Note swelling of leg & 2 small purple bullae on anterior shin
- Pressures in the anterior/lateral compartments (blood at needle entry) elevated; surgical exploration performed

Treatment of Necrotizing Fasciitis

- Think of it
 - Pain out of proportion to exam
 - Abnormal vital signs
 - Rapid spread
 - Tense edema
 - Ecchymoses
 - Crepitus
 - Loss of sensation
- Therapy = Surgical debridement: sometimes several times needed to achieve source control
- Watch out: imaging can be negative/misleading, patient may appear nontoxic at presentation (espec if young, otherwise healthy)
- Appropriate antimicrobial therapy – *B*-lactam + clindamycin or linezolid (IDSA Guideline Update pending)

Table 1. Signs and Symptoms of Necrotizing Soft Tissue Infection

Sign	Percentage of patients at presentation
Classic	
Bullae	25.6
Skin necrosis	24.1
Crepitus	20.3
Gas on radiographic evaluation	24.8
Nonspecific	
Swelling	80.8
Pain or tenderness	79
Erythema	70.7
Warmth	44
Fever >37.5 °C	40
Hypotension	21.1

McDermott et al. JAMA Surgery November 2024; Vol 159 (11): 1308

Table 2. Differential Diagnoses and Distinguishing Features From NSTI

Differential diagnosis	Distinguishing features from NSTI
Cellulitis	- Often not associated with hemodynamic instability, shock, or severe pain - Less associated with violaceous skin changes
Pyoderma gangrenosum	- Not associated with sepsis, fever - Associated with inflammatory bowel disease - Progresses slower than NSTI - Violaceous ulcer edges - Resistant to blunt dissection - Typically has negative blood and tissue cultures
Pyomyositis	- Characterized by abscess formation in muscles - Imaging shows focal muscle swelling and well-demarcated areas of fluid
Deep vein thrombosis	- Pain is less severe than that of NSTI - Fever may be present, though less common than in NSTI
Erysipelas	Raised, sharply demarcated borders

Abbreviation: NSTI, necrotizing soft tissue infection.

McDermott et al. JAMA Surgery November 2024; Vol 159 (11): 1308

Table 3. Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) Score

Variable	Value	Score
White blood cell count (×10 000/μL)	<15	0
	15-25	+1
	>25	+2
Hemoglobin, g/dL	>13.5	0
	11-13.5	+1
	<11	+2
Sodium, mEq/L	≥135	0
	<135	+2
Glucose, mg/dL	≤180	0
	>180	+1
Creatinine, mg/dL	≤1.6	0
	>1.6	+2
C-reactive protein	<15 mg/dL	0
	≥15 mg/dL	+4

SI conversion factors: To convert creatinine to μmol/L, multiply by 88.4; glucose to mmol/L, multiply by 0.0555.

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Table 4. Empirical Antibiotics for Necrotizing Soft Tissue Infections in Patients With Normal Kidney Function

Patient status	Antibiotic combination
Stable	One of the following antibiotics: - Amoxicillin/clavulanate, 1.2/2.2 g every 8 h - Ceftriaxone, 2 g every 24 h + metronidazole, 500 mg every 8 h - Cefotaxime, 2 g every 8 h + metronidazole, 500 mg every 8 h Plus - Clindamycin, 600-900 mg every 8 h or Linezolid
Unstable	One of the following antibiotics: - Piperacillin/tazobactam, 4.5 g every 6 h - Meropenem, 1 g every 8 h - Imipenem/cilastatin, 500 mg every 6 h Plus One of the following antibiotics: - Linezolid, 600 mg every 12 h - Tedizolid, 200 mg every 24 h Or One of the following antibiotics: - Vancomycin, 25-30 mg/kg loading dose, then 15-20 mg/kg dose every 8 h - Daptomycin, 6-8 mg/kg every 24 h - Telavancin, 10 mg/kg every 24 h Plus - Clindamycin, 600-900 mg every 8 h

Linezolid not inferior to Clindamycin as adjunctive anti-toxin therapy

McDermott et al. JAMA Surgery November 2024; Vol 159 (11): 1308
*Babiker et al. Lancet 2025; Vol 25: 265

27 Skin And Soft Tissue Infections

Speaker: Helen Boucher, MD



Anatomy	Syndrome
Epidermis	Erysipelas
Skin	Impetigo
	Folliculitis
	Ecthyma
Dermis	Furunculosis
	Carbunculosis
	All of this is Cellulitis
Superficial fascia	
Subcutaneous tissue	Necrotizing fasciitis
Subcutaneous fat, Nerves, arteries, veins	
Deep fascia	
Muscle	Myonecrosis (clostridial and non-clostridial)

Question #8

- A 50-year-old African American male fisherman with known cirrhosis suffers an abrasion of his leg while harvesting oysters
- Within hours, the skin is red, painful, and hemorrhagic bullae appear

Which one of the following conditions predisposes to this infection?

- A. G6PD Deficiency
- B. Hemochromatosis
- C. Sickle cell disease
- D. Achlorhydria

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Vibrio vulnificus

- Leading cause of shellfish (e.g., oysters) associated deaths in USA
- Portal of entry: skin abrasions or GI tract
- Liver disease, **hemochromatosis**, and exposure to estuaries are major risk factors
- **Infected wounds manifest as bullae in 75%; primary bacteremia also occurs**
- Treatment (look up): doxycycline plus ceftriaxone (alternative is a fluoroquinolone)

Organisms Whose Growth is Stimulated by Excess Iron

- | | |
|-----------------------------------|---|
| • <i>Vibrio vulnificus</i> | V |
| • <i>Escherichia coli</i> | E |
| • <i>Listeria monocytogenes</i> | L |
| • <i>Aeromonas hydrophila</i> | A |
| • <i>Rhizopus species (Mucor)</i> | R |
| • <i>Yersinia enterocolitica</i> | Y |

Definition: “The sails of a ship”

Thank You!

- David Gilbert
- Paul Auwaerter

Our patients and their families

Questions, Comments?

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