DELAWARE ACADEMY OF FAMILY PHYSICIANS

Common Sports-related Infections in the Young Athlete

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2023 SPORTS MEDICINE SYMPOSIUM

DISCLOSURE

- I have no disclosures

LEARNING OBJECTIVES

At the conclusion of this presentation the learner will be able to:

1. Diagnosis, treat and prevent skin and soft tissues infections related to participation in sports by children and adolescents

2. Provide patients and families with appropriate guidance on returning to sports and other activities following infection with mononucleosis

3. Understand and support management of bone and joint infections related to sports injuries sustained by young athletes

Case 1

- 16 year old boy comes to your office with recurrent “boils” occurring in various places on his body including his arms, legs and torso over the last few months
- The lesions usually start as red, warm, painful ”spots” then progress to pus-filled lesions that will spontaneously open up and drain pus; they eventually crust up and resolve but new ones appear in other places
- He does not have fever, nausea, vomiting, diarrhea or other significant symptoms associated with it and overall, generally feels well
- No prior history of this or any other serious infection, no one in his family/household has these
- No chronic medical problems or allergies; has had normal growth and development

Case 1 Continued

- Has tried OTC topical antibiotic ointments and antiseptic cleansing products without much improvement
- He is in high school and he is an offensive lineman for the football team; multiple other members of the team are having similar lesions
- No other significant exposures including travel, water or animal exposures
- His mother is wants to know where he could've gotten this infection or has he been exposed to something. She is also worried that since this keeps recurring, is there something wrong with his immune system

Common Types of Skin and Soft Tissue Infections (SSTIs)

- Cellulitis
- Erysipelas
- Impetigo (bullous)
- Folliculitis
- Abscess and Boils
- Toxin-mediated infections (ie Staph Scalded Skin Syndrome)

Most Common Pathogens Causing SSTIs (JK!!)

1. *Staphylococcus aureus*
2. *Staphylococcus aureus*
3. *Staphylococcus aureus*

…and Sometimes *Streptococcus pyogenes*

Methicillin-Susceptible Staph aureus (MSSA) V.S. Methicillin-Resistant Staph aureus (MRSA)?

Diagnosis

- Clinical Diagnosis
  - History
    - Exposures
    - History of previous infections including MRSA
  - Exam
    - Erythema, swelling, tenderness, warmth
    - Fluctuance & active purulent drainage
- Likely little utility for labs (CBC, inflammatory markers, blood culture) or imaging
- Drainage culture but cautious use of swab cultures of skin or lesion

Accessed https://publications.aap.org/redbook/visual-library 10/30/23

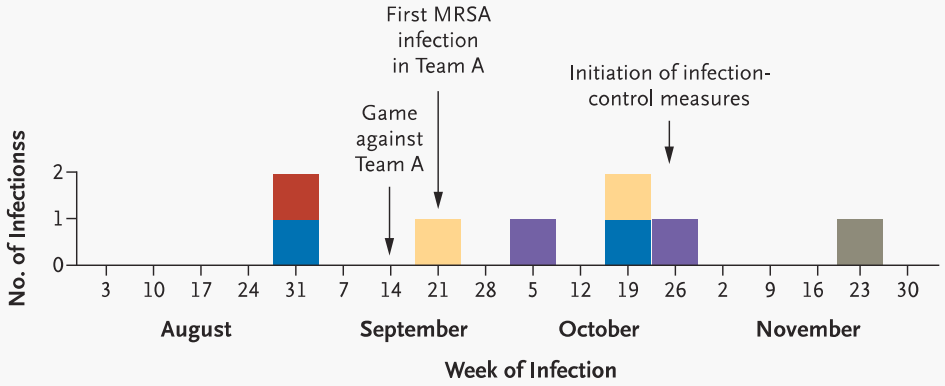
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

A Clone of Methicillin-Resistant *Staphylococcus aureus* among Professional Football Players

Sophia V. Kazakova, M.D., M.P.H., Ph.D., Jeffrey C. Hageman, M.H.S., Matthew Matava, M.D., Arjun Srinivasan, M.D., Larry Phelan, B.S., B.A., Bernard Garfinkel, M.D., Thomas Boo, M.D., Sigrid McAllister, B.S., M.T.(A.S.C.P.), Jim Anderson, B.S., A.T.C., Bette Jensen, M.M.Sc., Doug Dodson, B.S., David Lonsway, M.M.Sc., Linda K. McDougal, M.S., Matthew Arduino, Dr.P.H., Victoria J. Fraser, M.D., George Killgore, Dr.P.H., Fred C. Tenover, Ph.D., Sara Cody, M.D., and Daniel B. Jernigan, M.D., M.P.H.

N Engl J Med 2005;352:468-75



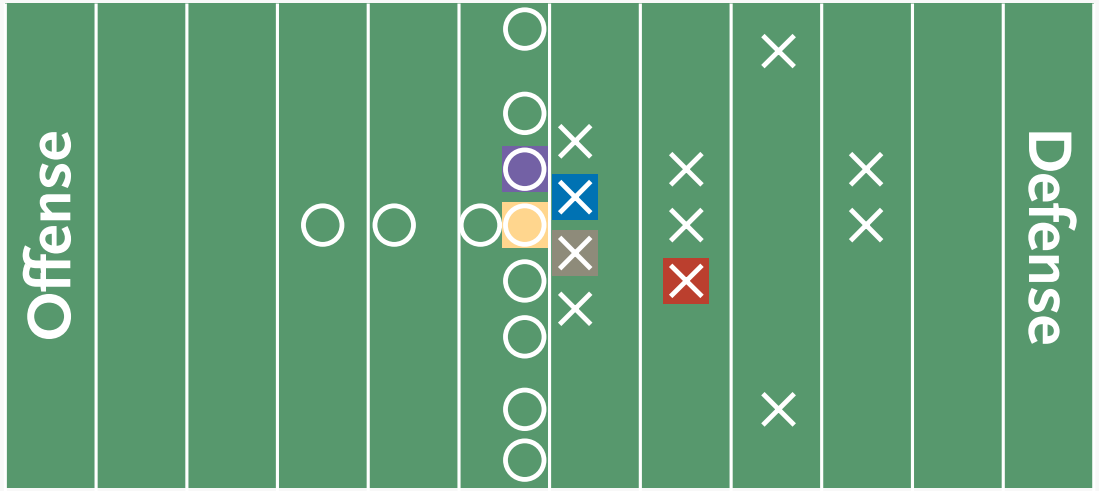


Figure 1. Epidemic-Curve Graph (Top) and Field Position Diagram (Bottom) of Cases of MRSA Infection among St. Louis Rams Professional Football Players in 2003.

Each box on the epidemic-curve graph and field diagram represents an MRSA infection; different colors designate different players; boxes of the same color thus represent recurrent infections. On the field diagram, X represents a defensive-player position and O an offensive-player position.

Table 1. Risk Factors for Skin Abscesses Due to Community-Associated MRSA among 53 St. Louis Rams Football Players, August 1 through November 30, 2003.*

Risk Factor	Risk Factor Present			Relative Risk (95% CI)	P Value†
	All Respondents	MRSA Infection	No MRSA Infection		
Black race — no. of players (%)	25/53 (47)	3/5 (60)	22/48 (46)	1.7 (0.3–9.3)	0.55
Mean body-mass index‡	NA	35.8	31.1	NA	0.03
Lineman or linebacker position (vs. backfield position) — no. of players (%)	27/53 (51)	5/5 (100)	22/48 (46)	10.6 (1.3–∞)	0.02
Surgery in past year — no. of players (%)	16/53 (30)	3/5 (60)	13/48 (27)	3.5 (0.6–18.8)	0.13
Hospitalization in past year — no. of players (%)	10/53 (19)	0/5	10/48 (21)	0.4 (0–3.6)	0.33
Use of antimicrobials in past year — no. of players (%)	30/51 (59)	5/5 (100)	25/46 (54)	7.8 (0.5–∞)	0.06
Turf burns covered during games — no. of players (%)	39/50 (78)	3/5 (60)	36/45 (80)	0.4 (0.1–2.2)	0.31
Shaved body other than face — no. of players (%)	9/51 (18)	1/5 (20)	8/46 (17)	1.2 (0.2–9.2)	0.89
Gloves worn during games — no. of players (%)	44/52 (85)	5/5 (100)	39/47 (83)	2.2 (0.2–∞)	0.41
Gloves used >3 times (vs. 1, 2, or 3 times) before washing — no. of players (%)	29/46 (63)	2/5 (40)	27/41 (66)	0.4 (0.1–2.1)	0.26

* The data reflect information provided by the players who responded to the survey. CI denotes confidence interval, and NA not applicable. Percentages and relative risks were calculated on the basis of the total number of responses to each question.
† P values and confidence intervals are based on Fisher's exact and chi-square analysis for categorical variables and t-testing for continuous variables.
‡ The mean body-mass index is the weight in kilograms divided by the square of the height in meters.

N Engl J Med 2005;352:468-75

Acute Treatment for the Individual Athlete

- Incision and drainage is applicable; may not need antibiotics if full drained and no associated cellulitis
- Warm compresses and topical mupirocin
- Start empiric antibiotic therapy directed towards Staph aureus
- Definitive therapy based on culture identified pathogen and susceptibilities
- Shorter course of 5-7 days may be adequate
- Referral for more emergent care if signs/symptoms of more disseminated or invasive disease
- Counselling and reassures on etiology, exposures and prevention

Antibiotic Choices for Staph aureus

For MRSA

- Clindamycin
- TMP-Sulfa
- Linezolid
- Doxycycline
- Vancomycin
- Daptomycin
- Ceftaroline

Best Anti-Staph Meds

- Cephalexin (Keflex)
- Oxacillin
- Nafcillin
- Cefazolin

RED = Oral Formulations

NEMOURS CHILDREN'S HEALTH

2022 ANTIBIOGRAM

Percent of isolates susceptible to TESTED antimicrobial agents

GRAM NEGATIVE ORGANISMS	# of patients	Ampicillin	Amp/sulb	Amox/clav	Pip/Tazo	Cefazolin	Cefuroxime	Ceftriaxone	Ceftazidime	Cefepime	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin	Aztreonam	Trimethoprim/sulfa
Enterobacter cloacae complex	50	—	—	—	#	—	—	#	#	94	100	100	98	98	98[g]	#	88
Escherichia coli	520	52	59	85	98	74	92	94	94	94	99	99	90	92	#	93	75
Klebsiella oxytoca	35	—	66	94	94	3	89	91	97	97	100	100	97	97	#	91	94
Klebsiella pneumoniae	108	—	75	88	94	73	86	89	90	92	99	99	98	98	#	91	84
Proteus mirabilis	42	81	83	95	100	74	97	95	95	95	100	100	90	88	#	95	83
Pseudomonas aeruginosa	121	—	—	—	98	—	—	—	98	95	98	95	82	90	94[e]	88	—
Serratia marcescens 2021/2022	49	—	—	—	#	—	—	66	56	98	98	100	95	92	#	#	100

GRAM POSITIVE ORGANISMS	# of patients	Ampicillin	Penicillin IV Non-Mening	Oxacillin	Cefazolin	Ceftriaxone Non-Mening	Ceftriaxone Meningitis	Cefepime	Levofloxacin	Clindamycin	Tetracycline	Trimeth/sulfa	Vancomycin
Enterococcus faecalis	91	100[a]		—	—	—	—	—			#		100
Staphylococcus aureus MRSA	132	—	—	—	—	—	—	—		82	92	99	100
Staphylococcus aureus MSSA	338	—	—	100[b]	100[b]	#[b]	#[b]	#[b]		74	93	100	100
Staphylococcus, coag negative	77	—	—	44						#	#	70	100
Streptococcus pneumoniae	47		100[d]			100	94	#	100	95[c]	89	#	100

Organism: ER *S. aureus* isolates (n)	Clindamycin	Tetracycline	Trimeth/sulfa
MRSA (59)	78	93	100
MSSA (120)	75	90	100

Preventative Measures for Athlete

- Good skin hygiene and skin care
- Early acute treatment interventions
- Decolonization for community-acquired MRSA (CA-MRSA)?
  - Mixed efficacy/success rates reported in literature and anecdotally
  - No definitive regimen
    - Mupirocin ointment (nares, axilla, nails, perianal?) 3 times daily for 5 days
    - Bathing/washing with dilute bleach baths or chlorhexidine wash 2-7 days per week
    - Daily change of clothing and washcloths and towels
    - Consideration of regimen for other household members; ?treatment of pets and surfaces
    - Course of systemic antibiotics? One antibiotic vs. combination (clindamycin, doxycycline, rifampin, trimethoprim)
  - Consider with severe cases, history of invasive disease or underlying conditions (severe eczema, immunodeficiency)
  - May help to decrease frequency of infections but complete eradication may not be possible

Preventative Strategies for the Teams

TABLE 2. MRSA Prevention Strategies

1. Frequent hand washing with soap or alcohol-based hand sanitizers
2. Showering with soap and water before and after practice sessions and games
3. Cover all infected wounds with occlusive dressings
4. Perform frequent skin inspections
5. Educate athletes to report skin lesions to training staff
6. Use universal precautions for all wound care
7. Cleanse all wounds regularly with soap and water
8. Cleaning equipment, playing surfaces, locker facilities with 1:100 bleach and water solution or a bactericidal solution
9. Prohibit sharing of equipment, towels, water bottles, topical medications, or skin products
10. Launder uniforms and workout care after each use

Box 1 Measures instituted for preventing staphylococcal skin infections[4]

- Cover all wounds
- Encourage good hygiene, including showering and washing with soap after all practices and competitions
- Ensure availability of adequate soap and hot water and replacing bar soaps with liquid soap
- Discourage sharing of towels and personal items
- Not allowing athletes in whirlpools when they had open wounds
- Routine cleaning for shared equipment
- Train athletes and coaches in first aid for wounds and recognition of wounds that are potentially infected
- Encourage athletes to report skin lesions to coaches and encourage coaches to assess athletes regularly for skin lesions

1. Benjamin HJ, et al. Clin J Sport Med, 2007
2. Sutton SS, et al. Br J Sports Med, 2014

Case 2

- 17 year old boy presents with “rash” on his face
- Started as clear-filled pimple-like vesicles that spontaneously burst than scabbed and crusted over
- No fever or constitutional symptoms
- Previously healthy without history of similar lesions or significant allergy history
- No new exposures including new facial soaps or lotions
- He is a very competitive wrestler and participated in a tournament 10 days ago

AN OUTBREAK OF HERPES GLADIATORUM AT A HIGH-SCHOOL WRESTLING CAMP

EDWARD A. BELONGIA, M.D., JESSE L. GOODMAN, M.D., EDWARD J. HOLLAND, M.D.,
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MARTIN W. MIZENER, M.D., ALEJO ERICE, M.D.,
AND MICHAEL T. OSTERHOLM, PH.D., M.P.H.

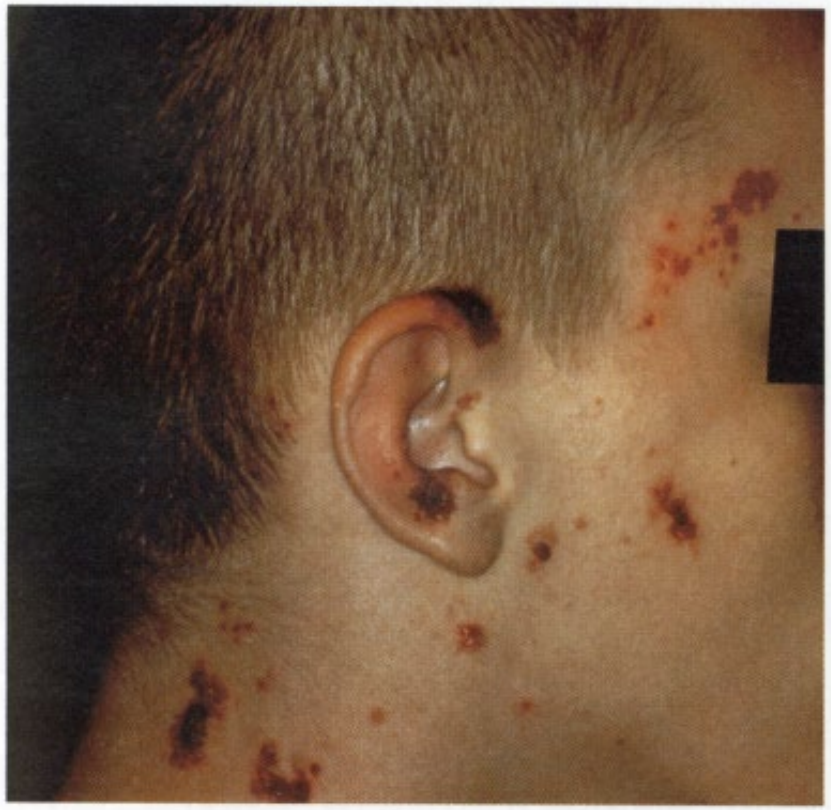


Figure 2. Typical Herpes Gladiatorum (HSV-1) Lesions on the Head and Neck of One of the High-School Wrestlers during the Outbreak.

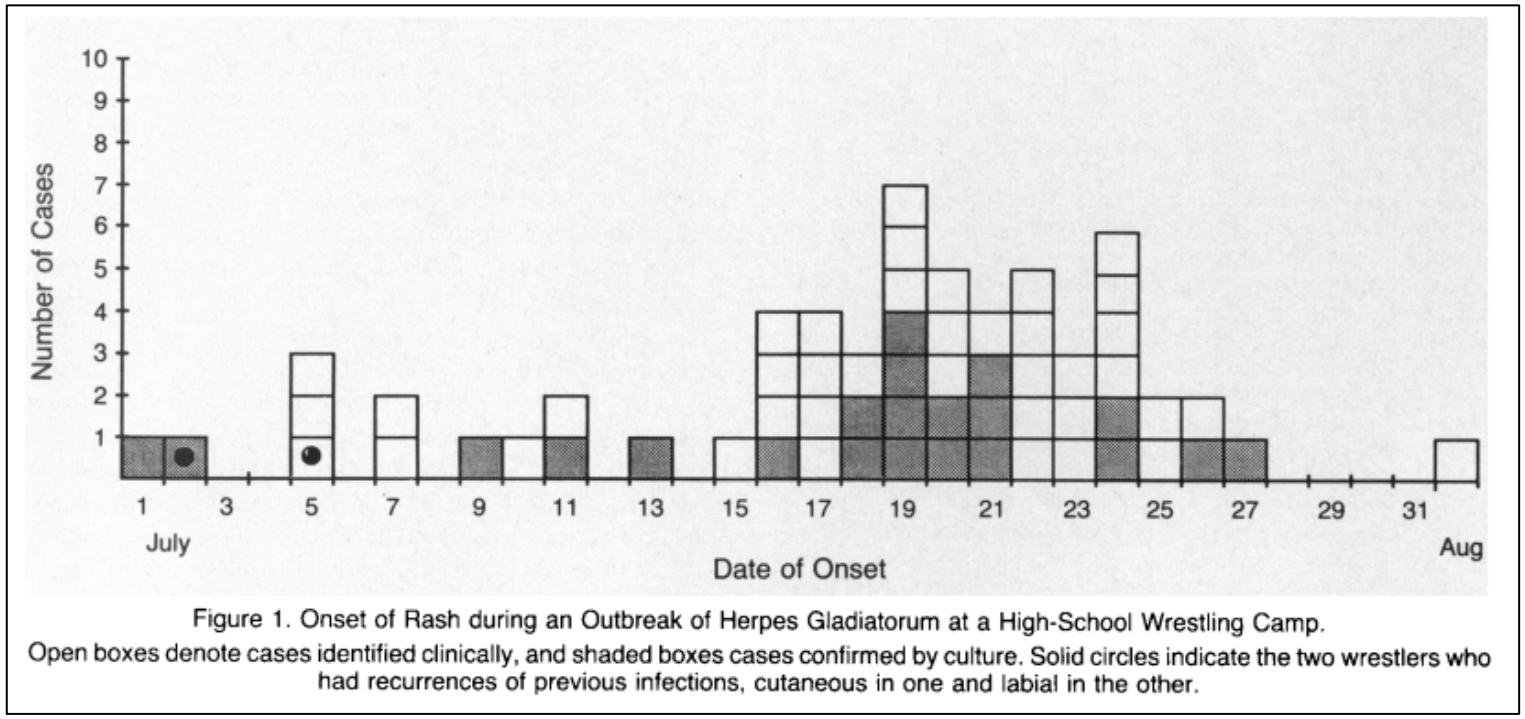
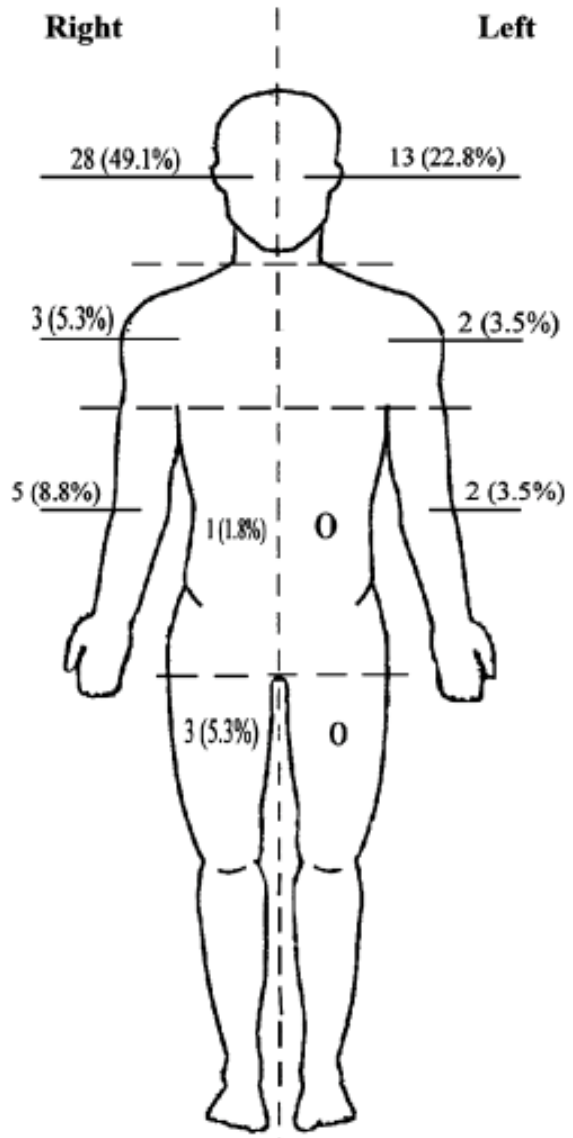


Figure 1. Onset of Rash during an Outbreak of Herpes Gladiatorum at a High-School Wrestling Camp.
Open boxes denote cases identified clinically, and shaded boxes cases confirmed by culture. Solid circles indicate the two wrestlers who had recurrences of previous infections, cutaneous in one and labial in the other.

N Engl J Med 1991; 325:906-910

Herpes Gladiatorum

- Seen in wrestlers, mixed martial arts participants
- Head and neck region due to nature of contact
- Mostly due to Herpes Simplex Virus-1 (HSV-1) but reported case of HSV-2
- Can present several days or even weeks after exposure/infection
- Can recur because of latent residence of virus in nerve root ganglia
- Rarely cause invasive, disseminated infection but can cause severe disease of the eye/retina
- Diagnosis: clinical, history and exam; can send PCR testing from lesion to confirm (swab base of lesion NOT fluid)
- Treatment: Acyclovir 20mg/kg/dose 4 times/day or valacyclovir 1 gram Q12 hours for 7-10 days (1st episode) 5-10 days (recurrence)
- Prevention:
  - For individual: Suppression- acyclovir 20mg/kg/dose 2-3 times/day or valacyclovir 500 mg daily
  - For teams: Similar interventions to Staph aureus prevention strategies



Location of lesions from 57 wrestlers with Primary Herpes Gladiatorum.

Anderson, BJ. Current Sports Medicine Reports, 2008; 7:323-327

Other SSTI infections in the Young Athlete

- Molluscum (wrestlers, MMA)
- Tinea corporis (Ring worm) (wrestlers, MMA)
- Pseudomonas aeruginosa (Swimmer's ear and hot tub folliculitis)

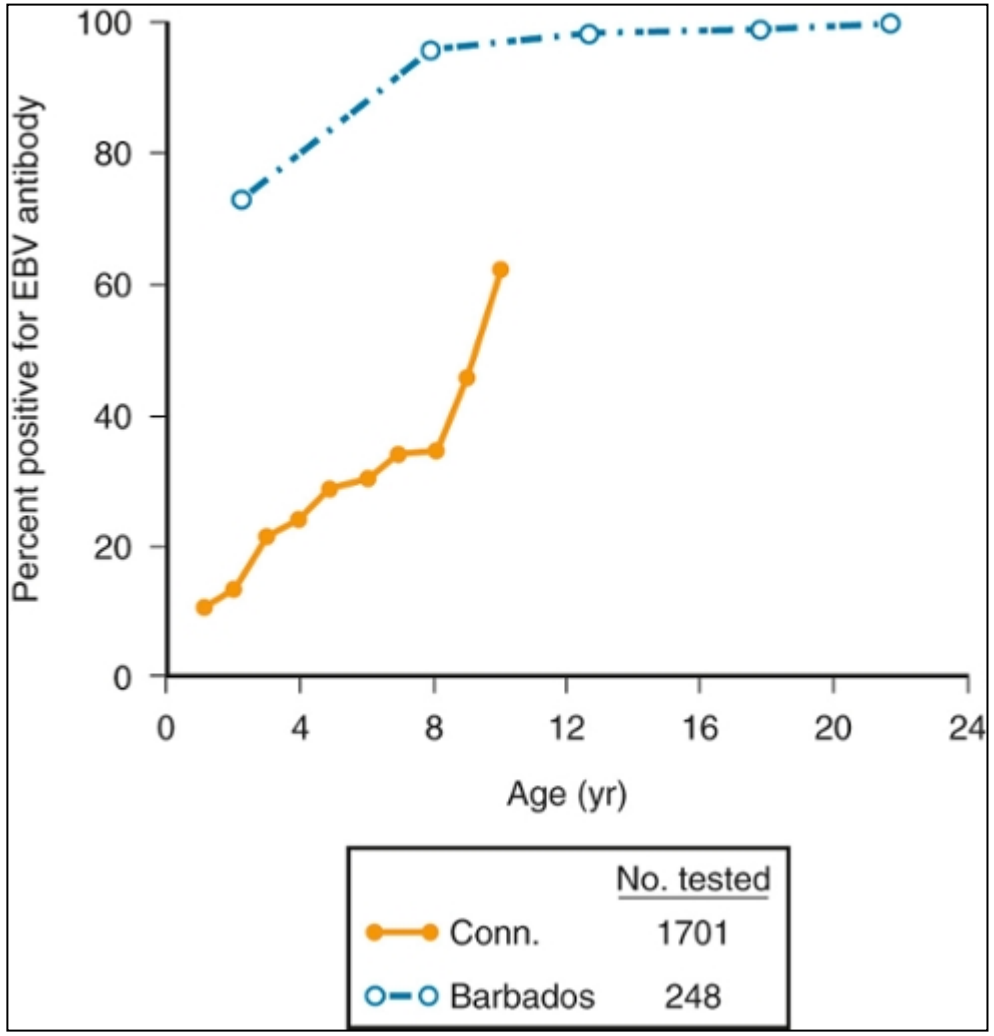
Thompson AJ, et al. Derm Online J. 2014; 20(6):16

Case 3

- 14 year old girl presents with several weeks of fatigue, intermittent fever and some left-sided abdominal distention
- 3-4 weeks prior, she had persistent fever, sore throat and enlarged neck lymph nodes; treated empirical with amoxicillin for Strep throat (broke out in a rash during treatment and now labelled with penicillin allergy
- No significant past medical history or allergies
- No significant exposures including sick contacts, denies being sexually active
- Freshman in high school and plays soccer but not playing because of this ongoing illness
- On exam, her spleen tip is palpable and liver edge 2-3 cm below costal margin

Thompson AE.*JAMA.* 2015;313(11):1180

Epidemiology of IM



- 90% of children in developing countries/lower socioeconomic populations in industrial nations contract EBV by 8 years of age[1]
- 30-75% of adolescents seronegative in higher socioeconomic groups[1]
- 90% of US adults have been infected[2]
- Young=asymptomatic or mild; Older=IM

1. Katz, Ben Z. *Epstein-Barr Virus (Mononucleosis and Lymphoproliferative Disorders)*. In Principles and Practice of Pediatric Infectious Diseases. Long SS, Fischer M, Prober CG (Eds). Elsevier Science, 5th Edition (2018)
2. American Academy of Pediatrics, Report of the Committee on Infectious Diseases, Red Book 2018-2021 Edition

TABLE 1.—CLINICAL MANIFESTATIONS OF INFECTIOUS MONONUCLEOSIS*

SYMPTOMS	FREQUENCY (%)	SIGNS	FREQUENCY (%)
Malaise and fatigue	90–100	Adenopathy	100
Sweats	80–95	Fever	80–95
Sore throat, dysphagia	80–85	Pharyngitis	65–85
Anorexia	50–80	Splenomegaly	50–60
Nausea	50–70	Bradycardia	35–50
Headache	40–70	Periorbital edema	25–40
Chills	40–60	Palatal enanthem	25–35
Cough	30–50	Liver and spleen tenderness	15–30
Myalgia	12–30	Hepatomegaly	15–25
Ocular muscle pain	10–20	Rhinitis	10–25
Chest pain	5–20	Jaundice	5–10
Arthralgia	5–10	Skin rash	3–6
Photophobia	5–10	Pneumonitis	<3

*Adapted from Finch[29] with permission of the author and Blackwell Scientific Publications.

Chervenick, PA. Dis Mon. 1974:1-29

Table 1. Differential Diagnosis of Infectious Mononucleosis

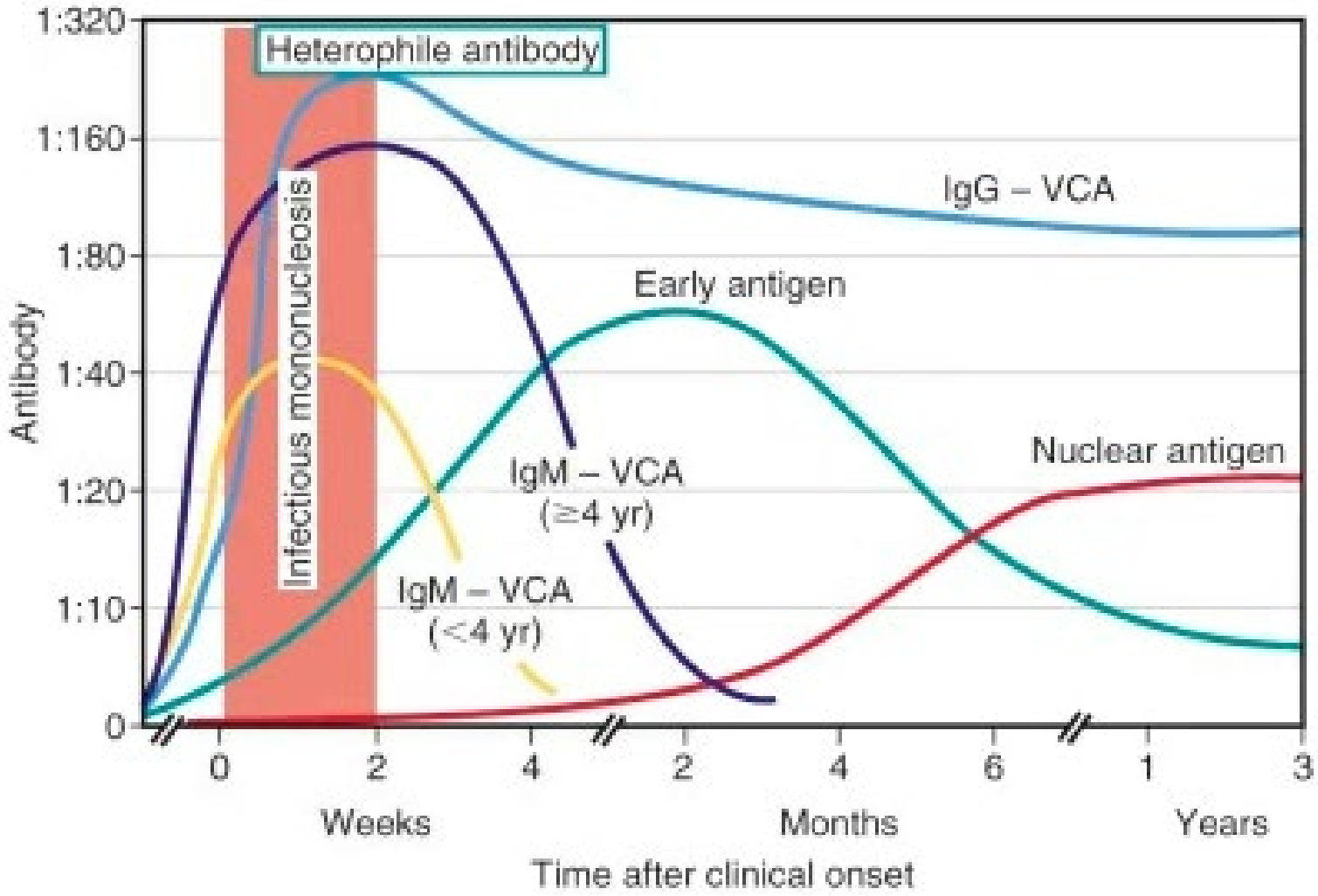
Diagnosis	*Key distinguishing features*
Acute human immunodeficiency virus infection	Mucocutaneous lesions, rash, diarrhea, weight loss, nausea, vomiting
Cytomegalovirus infection	Paired IgG serology shows a fourfold increase in antibody titers and a significant elevation in IgM (at least 30% of IgG value)
Streptococcal pharyngitis	Absence of splenomegaly or hepatomegaly; fatigue is less prominent
Toxoplasmosis	Recent history of eating undercooked meat or cleaning a cat's litter box
Other viral pharyngitis	Lymphadenopathy, tonsillar exudates, fever, and absence of cough are less likely than with streptococcal pharyngitis or infectious mononucleosis

IgG = immunoglobulin G; IgM = immunoglobulin M.

Adapted with permission from Ebell MH. Epstein-Barr virus infectious mononucleosis. Am Fam Physician. *2004;70(7):1281.*

Womack J & Jimenez M.. Am Fam Physician. 2015

Serologic Response to EBV Infection



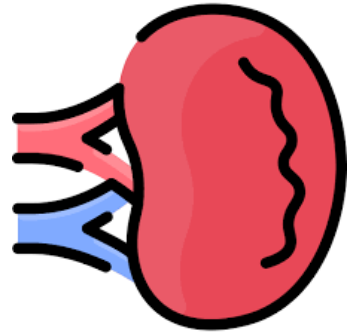
In Nelson Textbook of Pediatrics. Kliegman RM et al. (Eds). Elsevier Science, 20th Edition (2016)

Serum Epstein-Barr Virus (EBV) Antibodies in EBV Infection

Infection	VCA IgG	VCA IgM	EA (D)	EBNA
No previous infection	–	–	–	–
Acute infection	+	+	+/–	–
Recent infection	+	+/–	+/–	+/–
Past infection	+	–	+/–	+

American Academy of Pediatrics, Report of the Committee on Infectious Diseases, Red Book 2018-2021 Edition

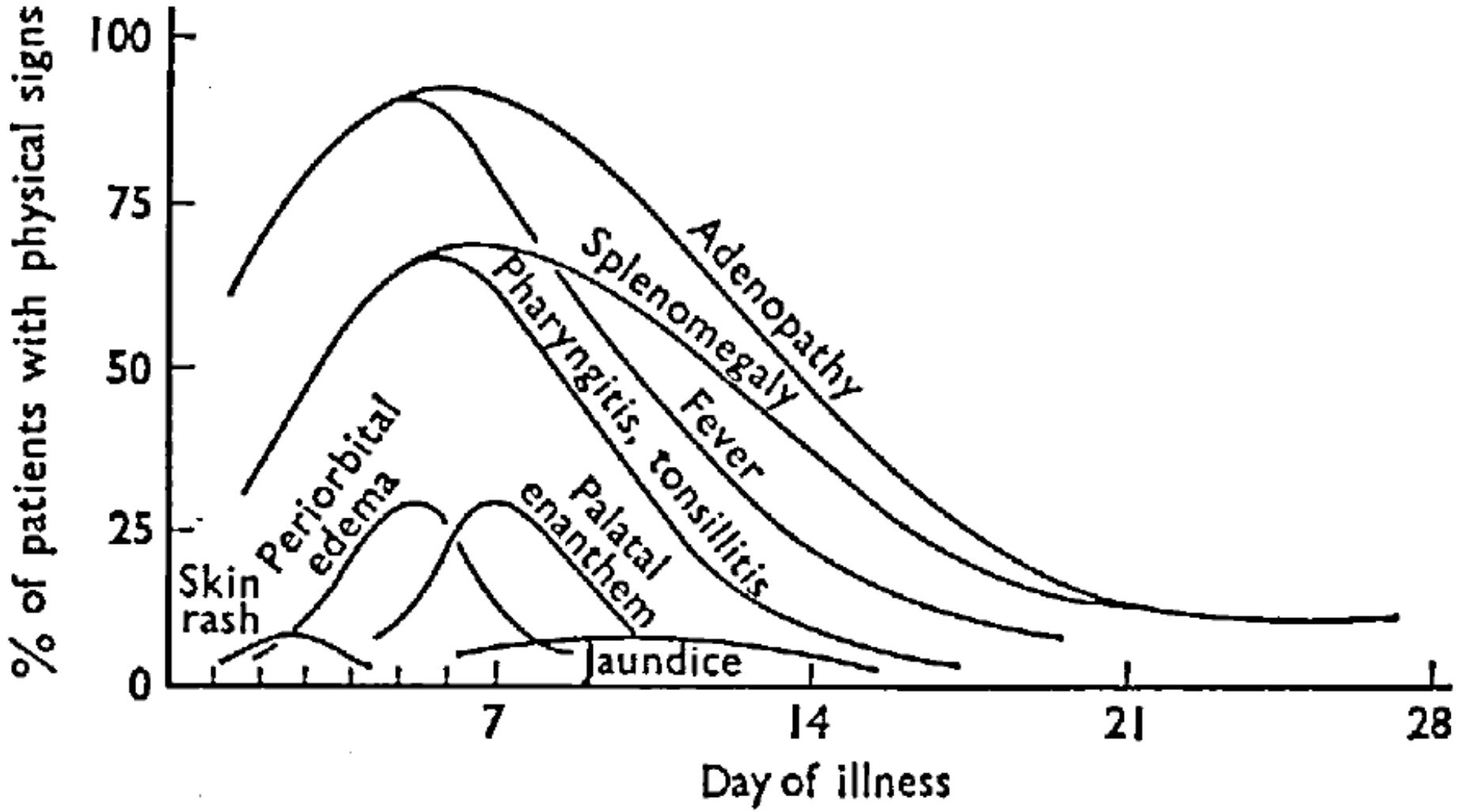
Splenomegaly in IM



- Moderate enlargement occurs in approximate 20% of cases
- Occurs 2-3 weeks into illness; usual asymptomatic
- Concern for splenic rupture-> hemorrhage->shock->death (rare)
- Splenic rupture rate <0.5% in adults and likely less in children[1]
- Most occur in 1st 3 weeks of illness but as late as 7 weeks[2]

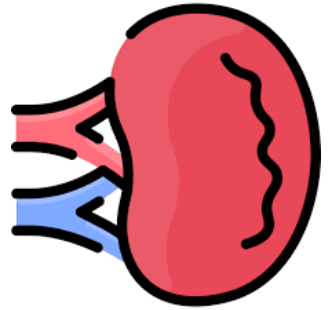
1. In Nelson Textbook of Pediatrics. Kliegman RM et al. (Eds). Elsevier Science, 20th Edition (2016)
2. Katz, Ben Z. *Epstein-Barr Virus (Mononucleosis and Lymphoproliferative Disorders)*. In Principles and Practice of Pediatric Infectious Diseases. Long SS, Fischer M, Prober CG (Eds). Elsevier Science, 5th Edition (2018)

FIG. 1.—Usual frequency and duration of major physical signs in young adults with uncomplicated infectious mononucleosis. (From Finch,[29] courtesy of the author and Blackwell Scientific Publications.)



Chervenick, PA.. Dis Mon. 1974;:1-29

Management of Splenomegaly



- Strenuous activity & contact sports avoided for 21 days after onset of symptoms[1]
- Limited non-contact aerobic activity after 21 days with no symptoms or overt splenomegaly[1]
- Clearance for contact sports after 4-6 weeks following onset of symptoms if asymptomatic and no splenomegaly[1]
- Minimal utility in repeat imaging (ultrasound or CT) or EBV testing
- Lack of data to support use of spleen guards
- Return-to-play decision needs to be individualized because of variable disease course & lack of evidence-based guidelines[2]

1. American Academy of Pediatrics, Report of the Committee on Infectious Diseases, Red Book 2018-2021 Edition
2. Becker JA & Smith JA.. Sports Health 2014; 6:232-238.

Overall Treatment for IM

- Self-limiting and supportive care
- Lack of data supporting use of steroids for anti-inflammatory effects to relieve symptoms; consider for severe airway obstruction
- Acyclovir, valacyclovir, ganciclovir have shown in vitro activity against EBV but no established efficacy or benefit; NOT recommended
- Treatment with antibiotics (penicillin, amoxicillin) may cause drug reaction rash and patients may be mislabeled as penicillin allergic

Case 4

- 13 year old boy presenting with worsening redness, swelling, pain and drainage from a surgical wound from his left lower leg
- He suffered a tibial fracture a few weeks prior while racing motor bikes; he was wearing a helmet
- Surgical open reduction and internal fixation of his fracture without incident
- He is febrile but hemodynamically stable and otherwise well
- Plain radiography x-rays show healing fracture with associated surrounding soft tissue swelling
- Culture from the drainage fluid is obtained and he is empirically started on cefazolin; Orthopedics taking him to the OR for I&D

Various Cases of Sports-related Osteoarticular Infections

- Ice hockey player with pyogenic arthritis of his hip and sacroiliitis
- Competitive gymnast with vertebral osteomyelitis
- Competitive horseback rider with multifocal osteomyelitis of her foot following being stepped on by her horse
- Infection related to fracture/traumatic sports injury or sports-related orthopedics surgeries in football players, soccer players etc.

Differential Diagnoses

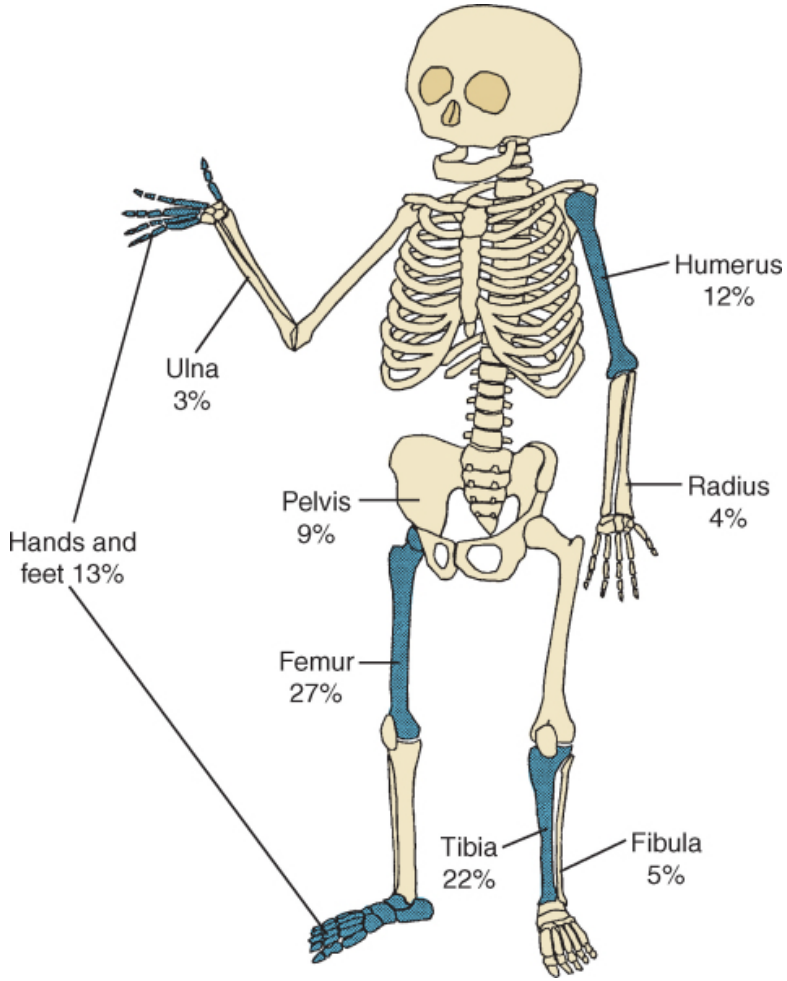
- Non-infectious overuse, stress or traumatic injury
  - Fever MAY help differentiate
- Aseptic arthritis
  - Rheumatologic causes
  - Lyme arthritis
- Chronic non-bacterial osteomyelitis (CNO) or chronic recurrent multifocal osteomyelitis (CRMO)
- Malignancy or other bony lesions

Diagnosis of Sports-related Osteoarticular Infections

- History and physical exam
  - Consideration of mechanism of injury-> hematogenous vs. contiguous spread-> consideration of microbiologic pathogens and empiric therapy
  - Fever, signs and symptoms of disseminated infection or sepsis
- Laboratory Evaluation
  - CBC with differential, CRP (not ESR); more for response to therapy than diagnostic; CMP for baseline renal and hepatic status
  - Blood culture, wound or drainage cultures
- Imaging
  - Choice of most appropriate imaging modality (US vs. x-ray vs. MRI)

Plain Radiographs

- Can be used to rule out other diseases:
  - Fractures, bone cyst, tumor, malignancy
- Three pathognomonic features:
  - Soft tissue swelling
  - Periosteal bone formation
  - Bone demineralization
- May detect deep soft tissue swelling or loss of soft tissue planes within first 3 days
  - 50% decrease in bone density required to show changes
  - Can take up to 10-20 days to develop



From Long et al. Principles and Practice of Pediatric Infectious Diseases, 5th ed.

Table 2. Comparative Diagnostic Accuracy of Different Imaging Modalities vs Magnetic Resonance Imaging (MRI) in Children With Suspected Acute Hematogenous Osteomyelitis (AHO)[a]

	N	Sensitivity (95% CI)	Specificity (95% CI)
MRI vs bone scintigraphy			
MRI	343	81% (64-93) to 100% (90-100) [4, 44, 77, 96]	67% (22-96) to 94% (86-98) [4, 96]
Bone scintigraphy	236	53% (38-67) to 91% (80-97) [4, 44, 77, 96]	47% (31-64) to 84% (60-97) [4, 96]
MRI vs CT scan			
MRI	57	81% (64-93) to 100% (82-100) [44, 96]	67% (22-96)[96]
CT scan	25	67% (38-88) to 100% (63-100) [44, 96]	50% (1-98)[96]
MRI vs ultrasonography			
MRI	95	81% (64-93) to 100% (91-100) [44, 45, 96]	67% (22-96)[96]
Ultrasonography	177	17% (9-28) to 60% (41-77) [44, 45, 96]	47% (24-70)[96]

Abbreviations: CI, confidence interval; CT, computerized tomographic; MRI, magnetic resonance imaging.

[a]Ranges of diagnostic test accuracy results were presented due to the small number of studies included in the analysis. Furthermore, missing information on absolute number of patients receiving the index tests according to the final diagnosis in the Malcius study precluded pooling of sensitivity and specificity. Various sources of heterogeneity between studies (eg, presence of verification bias, ie, not all tests were performed in all patients, or significant difference of timing between tests) and variation in reference standard (based on MRI or other criteria) further impeded any meaningful interpretation of pooled results [4, 44, 45, 77, 96].

Woods CR, et al. JPIDS. 2021; 10:801-844

- Use of MRI may be limited if orthopedic hardware already in place or due to sedation

TABLE 77.1 Frequency of Joint Involvement in 1050 Children with Pyogenic Arthritis

Data from references 4, 5, 7, 8, 96, and 98.

Anatomic Site	No. of Patients	Percentage (%) of Patients
Knee	467	41
Hip	287	25
Ankle	143	13
Elbow	116	10
Shoulder	53	5
Other[a]	70	6
Total[b]	1136	100

Modified From Long et al. Principles and Practice of Pediatric Infectious Diseases, 5th ed.

Synovial Fluid Characteristics for Causes of Arthritis

Diagnosis	WBCs/mm^3 (Typical)	WBCs/mm^3 (Range)	% PMNs (Typical)
Normal	<150	—	<25
Bacterial arthritis	>50,000	2000–300,000	>90
Tuberculous arthritis	10,000–20,000	40–136,000	>50 (range, 10–99)
Lyme arthritis	40,000–80,000	180–140,000	>75
Candidal arthritis	—	7500–150,000	>90
Viral arthritis	15,000	3000–50,000	<50 (variable)
Reiter syndrome	15,000	10,000–22,000	>70 (range, 37–98)
Rheumatoid arthritis	—	2000–50,000	>70
Rheumatic fever	25,000	2000–50,000	>70

PMNs, polymorphonuclear cells; WBCs, white blood cells.

Modified From Long et al. Principles and Practice of Pediatric Infectious Diseases, 5th ed.

Treatment of Osteoarticular Infections

- Most will likely need surgical intervention
- Empiric initiation of antibiotic therapy prior to surgery if hemodynamically stable
- Empiric therapy may need to be broad depending on situation
  - Most likely due to Staph aureus (MSSA vs MRSA)
  - Consider Gram negative and anaerobic coverage if ”dirty” wound or hardware involvement
- Definitive antibiotic coverage based on culture data
- Duration of therapy depends on type of infection
  - Pyogenic arthritis: 2-3 weeks
  - Acute osteomyelitis: 4-6 weeks
  - Chronic osteomyelitis: 2-3 months
  - Osteomyelitis with retained orthopedic hardware: acute therapy + suppression therapy as longer as 6 months total
- Initial intravenous therapy but can likely transition to oral therapy

Dosage of Antibiotics Commonly Used in the Oral Phase of Treatment of Osteomyelitis

Antibiotic	mg/kg per day	Divided/doses/day
Dicloxacillin	75-100	4
Cephalexin	100	3-4
Clindamycin	30-40	3-4
Linezolid	20-30	2-3

Modified From Long et al. Principles and Practice of Pediatric Infectious Diseases, 5th ed.

REFERENCES

1. AAP Red Book Visual Library: https://publications.aap.org/redbook/visual-library
2. Kazakova S, et al. A clone of methicillin-resistant Staphylococcus aureus among professional football players. *The New England Journal Medicine*. 2005; 352: 468-75.
3. Benjamin HJ, et al. Practical management: community-associated methicillin-resistant Staphylococcus aureus (CA-MRSA): the latest sports epidemic. *Clinical Journal of Sports Medicine.* 2007; 17:393-396.
4. Sutton SS, et al. Tackling community-acquired methicillin-resistant Staphylococcus aureus in collegiate football players following implementation of an anti-MRSA programme. *British Journal of Sports Medicine.* 2014; 48:284-285.
5. Belongia EA, et al. An outbreak of herpes gladiatorum at high-school wrestling camp. *The New England Journal Medicine*. 1991; 325:906-910.
6. Anderson, BJ. Managing herpes gladiatorum outbreaks in competitive wrestling: the 2007 Minnesota experience. *Current Sports Medicine Reports.* 2008: 7:323-327.
7. Thompson AJ, et al. Molluscum gladiatorum. *Dermatology Online Journal.* 2014. 20(6):16.
8. Thompson AE. Infectious Mononucleosis. *JAMA.* 2015;313(11):1180.
9. Katz, Ben Z. *Epstein-Barr Virus (Mononucleosis and Lymphoproliferative Disorders)*. In Principles and Practice of Pediatric Infectious Diseases. Long SS, Fischer M, Prober CG (Eds). Elsevier Science, 5th Edition (2018).
10. American Academy of Pediatrics, Report of the Committee on Infectious Diseases, Red Book 2018-2021 Edition.
11. Chervenick, PA. Infectious mononucleosis. *Disease-a-month.*1974. Dec;1:1-29.
12. Womack J & Jimenez M. Common Questions About Infectious Mononucleosis. *American Family Physician*. 2015; 91:372-376.
13. In Nelson Textbook of Pediatrics. Kliegman RM et al. (Eds). Elsevier Science, 20th Edition (2016).
14. Becker JA & Smith JA. Return to play after infectious mononucleosis. *Sports Health.* 2014; 6:232-238.
15. Hong DK & Gutierrez K. *Bone and Joint Infections (Osteomyelitis)*. In Principles and Practice of Pediatric Infectious Diseases. Long SS, Fischer M, Prober CG (Eds). Elsevier Science, 5th Edition (2018).
16. Woods CR, et al. Clinical Practice Guideline by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America: 2021 Guideline on Diagnosis and Management of Acute Hematogenous Osteomyelitis in Pediatrics. *Journal of Pediatric Infectious Diseases Society.* 2021;10:801-844.

DELAWARE ACADEMY OF FAMILY PHYSICIANS

QUESTIONS?

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THANK YOU!