HARRISON

EDITION 22nd

INFECTIOUS DISEASE

Infectious Disease

Mycobacterial Diseases	Completed
Spirochetal Diseases	Completed
Diseases Caused By Gram-Positive Bacteria Part 1	Completed
Diseases Caused By Gram-Positive Bacteria Part 2	Completed
Diseases Caused By Gram-Positive Bacteria Part 3 & Miscellaneous Bacterial Infections	Completed
Diseases Caused By Gram-Negative Bacteria Part 1	Completed
Diseases Caused By Gram-Negative Bacteria Part 3	Completed
Diseases Caused By Gram-Negative Bacteria Part 2	Completed
Fungal Infections	Completed
Infections Due To DNA Viruses	Completed
Spirochetal Diseases Part 2	Completed
Diseases Caused By Rickettsiae, Mycoplasmas And Chlamydiae	Completed
Infections Due To DNA And RNA Respiratory Viruses	Completed

- Infections Due To RNA Viruses — Completed
- Parasitology — Completed

Harrison 22nd Ed – Part 3

- Dr Swati Gupta

MD, DNB (Gold Medal), Infectious Disease Fellow, CICP (Silver Medal)

Tuberculosis – Definition & General

Caused by members of the *Mycobacterium tuberculosis* complex

- **Mycobacterium tuberculosis**
- **Mycobacterium bovis**
- **Mycobacterium africanum**
- **Mycobacterium microti**
- **Mycobacterium canettii**
- **Mycobacterium caprae**
- **Mycobacterium pinnipedii**
- **Mycobacterium mungi**
- **Mycobacterium suricattae**

Tuberculosis

I° **Pulmonary TB**

- **Ghon focus** = initial peripheral lesion ± **pleural reaction**.
- With hilar/paratracheal lymphadenopathy → **Ghon complex**.
- Common associated findings: **erythema nodosum**, phlyctenular conjunctiv



FIGURE 183-7 CT scan showing a large cavity in the right lung of a patient with active tuberculosis. (Courtesy of Dr. Elisa Busi Rizzi, National Institute for Infectious Diseases, Spallanzani Hospital, Rome, Italy, with permission.)



Different FOcus

- **Ghon focus** – primary lung lesion
- **Ghon complex** – Ghon focus + involved hilar lymph nodes.
- **Ranke complex** – healed/calcified Ghon complex.
- **Simon focus** – apical lesion from hematogenous spread, seen in secondary TB.
- **Assmann focus** – small apical infiltrate in early reactivation TB.
- **Rich focus** – brain/meningeal lesion that ruptures to cause tuberculous meningitis.
- **Miliary foci** – multiple millet-seed sized lesions in disseminated TB.
- **Pott's focus** – vertebral body lesion in spinal TB.

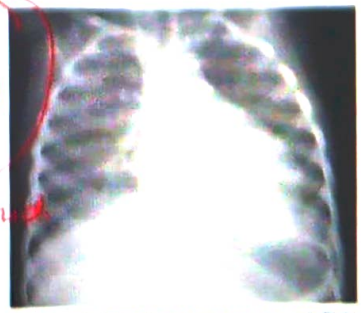
Postprimary

- **Typical sites:** apical/posterior segments of upper lobes, superior lower lobe segments
- **Cavitation** → necrotic contents drain into bronchi → **bronchogenic spread** → satellite lesions.
- **Rasmussen's aneurysm**

Extrapulmonary TB

1. Lymph Node TB (scrofula)
2. Pleural TB
   - Usually recent primary infection
   - AFB rarely seen
   - Adenosine deaminase (ADA) high
   - Tuberculous empyema





Extrapulmonary TB

- **Upper Airway TB** → Larynx → NC.
  phary, epi
  asympto till destruction.
- **Genitourinary TB** → A → urine → 3 consec morning → 90%.
  Female → FT
  Male → epididy
- **Skeletal TB**
  spine (40%), hip (13%),
  Potts. disc → late

CNS TB

CSF → lymph ↑ protein ↓ gluco.
↓ AFB (culture ~80%)
Insidious.
Xpert

1. **Tuberculous meningitis**
   - Basal meningitis → cranial nerve palsies, hydrocephalus, vasculitis
   - Xpert MTB/RIF sensitivity ~80%.
   - IV dexamethasone for 2–3 weeks → switch to oral, taper over 6–8 weeks.
     0.3-0.4 mg/kg/day.
2. **Tuberculoma**
   → CCL → seizure, RIC.

Extrapulmonary TB

Peritonitis → AFB ↓.
ADA
Crohn.
~~AGP~~ Biopsy.

- **GI TB**
- Sites: terminal ileum, cecum.

- **Pericardial TB**
- Subacute → pericardial effusion, tamponade.
  high mortality.

Miliary TB

- Hematogenous dissemination.
- **Granulomas 1–2 mm "millet seed".**
- **Choroidal tubercles pathognomonic** (up to 30%).
- Variants:
  - **Cryptic TB:** → elderly, indolent.
  - **Nonreactive septicemic TB:** → massive diss → DIC → fatal.

HIV-associated TB

- Presentation depends on CD4 count:
  - **>200/µL**: typical postprimary TB → UL consolidation.
  - **<200/µL**: atypical, primary-like TB → Int. Infiltrates, LN, PE.
- **Urine lipoarabinomannan (LAM) antigen** useful in advanced HIV.
- **IRIS –**
  - avoid starting ART in first 8 weeks of TB meningitis.
  - Severe IRIS: treat with **steroids (prednisolone ~1.5 mg/kg/day × 2 weeks, then taper)**.

Post-TB Sequelae

- **Chronic lung impairment** → fibrosis.
- **Aspergilloma** → Asymptomatic → hemoptysis.

Diagnosis

- ZN,
- Culture
- Molecular
- DST < Molecular, Phenotypic
- Latent TB

Min - 40-50 c.

2 sputum samples — 1 spot → early morning.
front loading → 2 spot (1 hr apart)

ZN - Ziehl Neelsen (10^4 bacilli/ml)
Fluorescent.

culture → Solid → Lowenstein media.
Liquid → Middlebrook 7H9

BACTEC → CO_2 ↑ → Radio.
MGIT → O_2 consump → fluorescent.
10-100 CFU/ml.
BACTAlert → colour change.

Rapid Ag Detection → MPT64 → culture.
→ Not for clinical spec.

LAM Urine Ag → HIV
→ CD4 < 200

NAAT.
Xpert MTB/RIF → PCR → TB + Rif (R) → 2hr.
Xpert ultra → "Trace calls" = True positive
→ TB + Rif (R) ↑↑ sen.
Xpert MTB/XDR → TB + Rif, INH, FQ
2nd line Injectable.

TrueNat → chip PCR.
LAMP → Loop mediated Isothermal Amplification
TB & Rif

DST.

Pheno. → solid → LJ → 8-12wk
liquid → MGIT → 4-6 wk.

Geno → LPA. → DNA strip. Reverse hybridization.
↓ MTI + drug.
5-7 h.

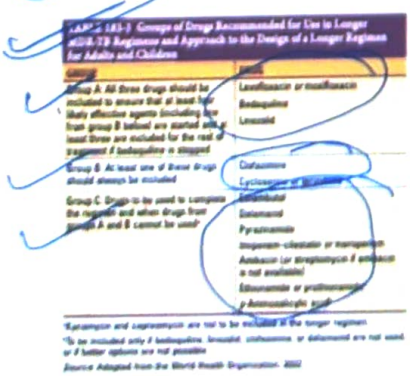
NGS → Rad.

Tests for TB Infection (Latent TB) +

1. TST
→ uses PPD
→ Induration. 48-72h. 5 10 15.
→ False + → BCG, NTM
False − → New TB, ICH, Boosted
→ 2step TST.

2. IGRA
Interferon γ Release.
TB Ag → IFN → measured
→ TSPOT. → ESAT / CFP
→ TB Gold → +/− → +TB
→ TB Gold plus → CD4, CD8.

Treatment



12-18:
18-20

Monitoring
monthly sputum.
Smear → 2, 5, 6.
NAAT X

PZA → gout → X
Rifa → Thrombocyt → X
EAA → optic neuritis.

Treatment

① H, R, Z, E.

DRTB
RIFa → RpoB.
INH → KatG > InhA
Pyr → PncA.
E → EmbB.

DRUG	DAILY DOSE	
	ADULT	PEDIATRIC
Isoniazid	5 mg/kg, max 300 mg	10 (7–15) mg/kg, max 300 mg
Rifampin	10 mg/kg, max 600 mg	15 (10–20) mg/kg, max 600 mg
Pyrazinamide	25 mg/kg, max 2 g	35 (30–40) mg/kg
Ethambutol	15 mg/kg	20 (15–25) mg/kg

*The duration of treatment with individual drugs varies by regimen, as detailed in Table 183-3.

Source: Based on recommendations of the American Thoracic Society/Infectious Diseases Society of America/Centers for Disease Control and Prevention and the World Health Organization.

mycolic ↓
Transcription
Hepl Gow
Red green

Cr.Cl < 30

① RRTB-

RRTB → Rifampin.
MDR TB → H + R
H mono DRTB → H.
Poly DR TB → > 1 FD (≠ H/R)
Pre XDR → MDR + 1 FQ.
XDR → MDR + FQ + ≥ 1 Group A.

MDR TB.

① BPaL(M) (6M)
Cl preg.
② 6 month. BDLLxCz.
③ 9 month → All oral
④ > 18 month
Dela Q1

FQ → M/L.
AG → All/S.
ETO → C/S Preg.
Cycloserine → CNS
↳ BMS.
BD BDQ → QT
400 mg
200 mg
x 2 hub.
thrice wd.

Treatment

TABLE 183-4 Recommended Antituberculosis Treatment Regimens

INDICATION	INITIAL PHASE		CONTINUATION PHASE	
	DURATION, MONTHS	DRUGS	DURATION, MONTHS	DRUGS
New drug-susceptible pulmonary or extrapulmonary[a] TB cases	2	HRZE[a]	4	HR[a,c]
New drug-susceptible pulmonary TB (12 years or older)	2	HPMZ[b,d]	2	HPM[b,d]
New non-severe[e] TB in children and adolescents aged 3 months to 16 years	2	HRZ(E)[a]	2	HR[a]
Pregnancy	2	HRE[f]	7	HR
Intolerance to Z	2	HRE	7	HR
Relapses, treatment default, failures	Tailored according to rapid drug susceptibility testing			
Resistance (or intolerance) to H	Throughout (6)	RZELfx		
MDR/RR-TB (see text for further details)	Throughout (6) BPaLM[g] for patients aged ≥14 years without previous exposure to B, L, and Pa.			
	Throughout (6) BDLLfxCfz for patients with no previous exposure to B, D, and L, including children, adolescents, and pregnant and breastfeeding women. Either Lfx and Cfz may be omitted depending on fluoroquinolone drug susceptibility testing. This regimen may be used in place of 9-month or longer regimens described below.			
	Throughout (9) BLMZ or BLLfxCfzZ or BDLLfxZ for patients with no previous exposure to B, D, and L, and in whom resistance to fluoroquinolones has been excluded. These regimens may be used in place of currently recommended longer (18-month) regimens described below.			
	Alternatively: all-oral, B-containing, 9-month regimen: 4 months of B (used for up to 6 months), Lfx or M, Eto or Pto, E, Hh, Z, Cfz followed by 5 months of Lfx or M, E, Z, Cfz for adults and children with no previous exposure to second-line treatment including B, in whom resistance to fluoroquinolones has been excluded, and in the absence of extensive pulmonary TB or severe forms of extrapulmonary TB.			
	In more complex forms of MDR/RR-TB (e.g., XDR-TB) longer (≥18 months) individualized regimens need to be formulated as per Table 183-3.			

Prevention

TABLE 183-5 Tuberculin Reaction Size and Cutoff for Tuberculosis (TB) Preventive Treatment

RISK GROUP	TUBERCULIN REACTION SIZE, mm
HIV-infected persons	≥5
Recent contacts of a patient with TB	≥5[a]
Organ transplant recipients	≥5
Persons with fibrotic lesions consistent with old TB on chest radiography	≥5
Persons who are immunosuppressed—e.g., due to the use of glucocorticoids or tumor necrosis factor α inhibitors	≥5
Persons with high-risk medical conditions[b]	≥5
Recent immigrants (≤5 years) from high-prevalence countries	≥10
Injection drug users	≥10
Mycobacteriology laboratory personnel; residents and employees of high-risk congregate settings[c]	≥10
Children <5 years of age; children and adolescents exposed to adults in high-risk categories	≥10
Low-risk persons[d]	≥15

Prevention

TABLE 183-6 Recommended Regimens and Drug Dosages for Tuberculosis Preventive Treatment*

REGIMEN	DOSE	ADVERSE EVENTS
Isoniazid alone for 6 or 9 months	Adults: 5 mg/kg (max, 300 mg) per day Children <10 years of age: 10 mg/kg per day (range, 7–15 mg)	Drug-induced liver injury, nausea, vomiting, abdominal pain, skin rash, peripheral neuropathy, dizziness, drowsiness, seizure
Rifapentine plus isoniazid for 3 months	Adults and children: Isoniazid: 15 mg/kg (900 mg) weekly Rifapentine: 15–30 mg/kg (900 mg) weekly	Hypersensitivity reactions, petechial skin rash, drug-induced liver injury Anorexia, nausea, abdominal pain Hypotensive reactions
Isoniazid plus rifampin for 3 months	As below	As above
Rifampin alone for 4 months	Adults: 10 mg/kg per day Children <10 years of age: 15 mg/kg (range, 10–20 mg) per day	Flulike syndrome, skin rash, drug-induced liver injury, anorexia, nausea, abdominal pain, neutropenia, thrombocytopenia, renal reactions (e.g., acute tubular necrosis and interstitial nephritis)
Rifapentine plus isoniazid for 1 month	Age >13 years only: isoniazid 300 mg and rifapentine 600 mg daily (28 doses)	Essentially similar to those of rifapentine plus isoniazid for 3 months with neutropenia more common and elevation in liver enzyme levels and neuropathy less common
Levofloxacin for 6 months	Daily: adults 10–15 mg/kg; children 15–20 mg/kg (maximum 750 mg)	No grade 3, 4 or serious adverse events reported

*See text for full description of evidence on and limitations of these regimens.
Source: Reproduced with permission from World Health Organization.

INH → 6-9 m.

INH + Rifapentin. → W X12.

X pur.

Leprosy

→ T ⟷ L.

12–14 days.

mouse footpad, armadillo.

Nerve damage.

Intracelle, Acid Fast.

AFB < viable → uniformly → Morphological Index
dead → fragmented → Bact.

Etiology

Age → Teenage, Adult:
W > M.

~~Disability~~

Nasal droplets

PB – 2-5 y.
MB – 5-10 y.

Host → poor.

Classification

Ridley Jopling (1962) → TT, BT, BL, LL, IL

WHO → Pauci → 1-5 skin; ≤1 Nerve; Smear (−)

Treatment: Multi → >5 skin; >1 Nerve, Smear (+)

Clinical manifestations

→ loss of fine touch & temp → Sm (−), Lep (+)





→ satellite..

High Risk Type 1 Reac.





→ Num.

Sm (+)(+)

① Histoid L → Le.
waxy, shiny nodule.
no glob.

② Diffuse/Lucio.
Necro vasculitis

③ Neuritic → Only Nerve.

Leprosy reactions



FIGURE 184-7 Type 1 leprosy reactions. Increased inflammation of existing lesions. (From Dr. W. H. van Brakel, with permission from NLR.)

Reversal R.

Borderline → Mitsuda's.

→ Cortico



FIGURE 184-8 Type 2 leprosy reaction. Erythema nodosum leprosum, with pustular lesions. (From Dr. H. K. Kar, with permission.)

ENL. Type III → Thalidomide.

Lepra R. → Corti co. Clofa.

Diagnosis

Clin →

Hyp. Thick AFB +

PGL-1 → ELISA.

sss → earlobe, eyebro. ~~buttock~~ chi → BF/Mj.

histo co.

Treatment

Pauci → 6M.

R 600mg once/m.
Dapso 100mg daily.

DHS → 6
2y

Relapse

Multi 5y 12M.

+ Clofazi 50mg daily.
+ 300mg once/m.

BI > 2+ with Clinical Det

Nontuberculous Mycobacteria (NTM)

MOTT → Runyon classi.
Photochro → M. marium
scotochr. → M. Scrofuli
Non photo → MAC.
Rapid grow → < 7days, M. fortui.

Clinical syndromes

① Diss. → Indolent.
Pul < fibro cavit → TB.
Nodular Bronchiectatic Dis.
"Lady Windermere" → MAC.
M. marium → fish tank granul.
M. ulcera → Buruli ulcer
mycolactone

Diagnosis

① ZN
② culture → < 7d
③ → Pul NTM → ① NTM >2/3 sputum
② 1 (+) BAL.
③ Lung Biopsy.

PPD. IGRA → M. mar.
M. Kansasii

Treatment

1. MAC → Macrolide + eth + Rif
   > 12 month
2. M. kansasii → TB → N+R+E x1y.
3. Rapid. → macrolide + Alt.

Antimycobacterial Agents

TABLE 186-2 Simplified Approach to Treatment of Active Tuberculosis (TB) in Adults

CULTURE RESULTS	INTENSIVE PHASE	CONTINUATION PHASE	EXTENSION OF TOTAL TREATMENT
Culture-positive, drug-susceptible	HRZE for 2 months, daily[a] or 3 times per week (with dose adjustment)	HR for 4 months, daily or 5 days per week *or* HR for 4 months, 3 times per week[a] (with dose adjustment)	Continuation phase extended to 7 months if 2 months of Z is not completed, if the patient is infected with HIV and is not receiving antiretroviral therapy, or if culture conversion is prolonged and/or cavitation is evident on chest radiography (U.S. guidelines)[b]
Culture-negative	HRZE for 2 months	HR for 2 months, daily or 2 or 3 times per week[a]	Continuation phase extended to 4 months if the patient is infected with HIV
Extrapulmonary, drug-susceptible	HRZE for 2 months	HR for 4–7 months, daily or 5 days per week[a]	Continuation phase extended to 10 months in TB meningitis; 7 months recommended by some authorities for bone/joint TB

Drug Resistant TB

TABLE 186-4 Simplified Approach to Treatment of Drug-Resistant Tuberculosis (TB) in Adults[a]

CULTURE RESULTS	INTENSIVE PHASE	CONTINUATION PHASE	EXTENSION OF TOTAL TREATMENT
Resistant to H	Lfx RZE[b] for 6 months	…	Prolonged culture conversion and/or evidence of cavitation on chest radiography
Resistant to HR (MDR); BPaLM Regimen[c]	Bdq, Pa, Lz, Mfx for 6 months (may drop Mfx if documented Q resistance)		Failed culture conversion at month 4–6, delayed clinical response. Treatment interruption of >7 days is made up by adding on to the total treatment duration.
WHO short-course regimen (9-month all-oral regimen)	Bdq plus Lfx or Mfx, Eto, E, Z, Hh, Clz for 4–6 months	Lfx or Mfx, Clz, Z, E for 5 months	
WHO extended regimen	At least four effective second-line agents, including all three group A and at least one group B, add group C if intolerant to A or B drugs for 5–7 months	At least 4 drugs for a total of 18–20 months or for 15–17 months after culture conversion	

Syphilis

→ Treponema Pallidum.





spirochete → Thin. spiral SS

↳ Treponem. pallidum → syphilis.
pertenue → yaws.
endemicum → Bejel.
Carateum → Pinta.

Syphilis

Patho. → Lymph → Blood.

5d → 21 day.

I° Chancre. → 4-6 wk.

II° → Rash, LN, condylomata.

III° → Gumma.
CV syphilis
Tab.

Resolve 2-6 wk

Latent → <12m
>1 yr.

↳ aortic.

Syphilis

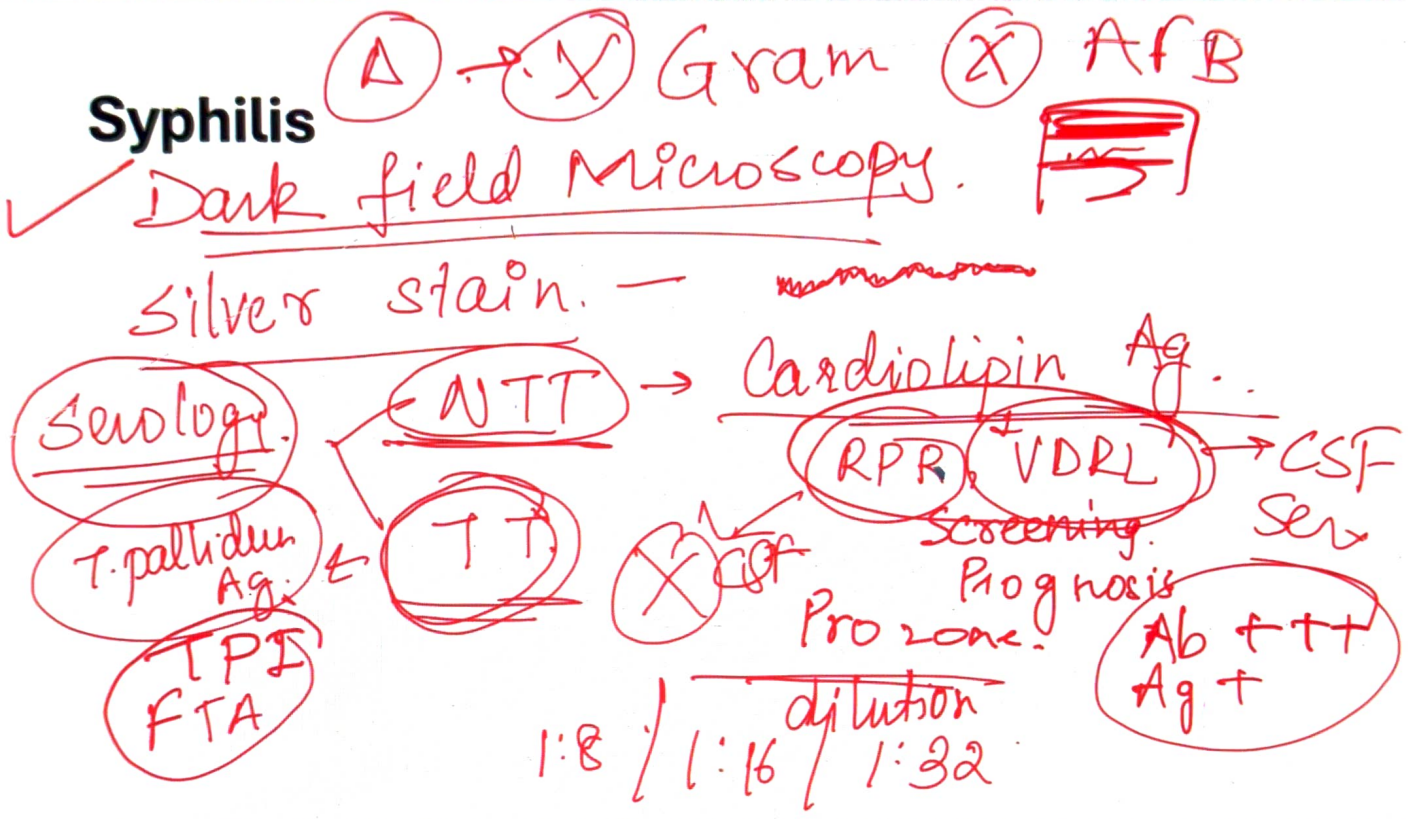
Congenital.

4th Before 16 wk

Early →

Late → Interstitis Keratitis.
→ 8th CN +
Hutchin teeth.
Mulberry Molar.
Saddle nose
Saber.

Syphilis



Testing.

Classic

→ screen → NTT (VDRL/RPR)

→ confir → TT (TPPA).

↓ false (+).

low prevelan.

Revese.

TT

NTT (RPR).

high prevelance.

Endemic Treponematoses

Azith.

PnG 1.2 M/I

TABLE 188-1 Classic Comparison of the Agents of the Human Treponematoses and Their Associated Diseases

FEATURE	SYPHILIS	YAWS	BEJEL (ENDEMIC SYPHILIS)	PINTA
Organism	*T. pallidum* subsp. *pallidum*	*T. pallidum* subsp. *pertenue*	*T. pallidum* subsp. *endemicum*	*T. carateum*
Common modes of transmission	Sexual, transplacental, skin-to-skin	Skin-to-skin	Mouth-to-mouth or via shared drinking/eating utensils, skin to skin, sexual[a]	Skin-to-skin
Usual age of acquisition	Sexual maturity or in utero	Childhood	Early childhood, adulthood[a]	Late childhood
Primary lesion	Mucocutaneous ulcer (chancre)	Papilloma, often ulcerative	Mucosal papule, rarely seen	Nonulcerating papule with satellites, pruritic
Common location	Genital, oral, anal	Extremities	Oral, occasionally sexual[a]	Extremities, face
Secondary lesions	Cutaneous rash and mucosal lesions; condylomata lata, ocular and otic syphilis	Cutaneous papillomatous or ulcerative lesions; condylomata lata, osteoperiostitis	Mucocutaneous lesions (mucous patch, split papule, condylomata lata); osteoperiostitis	Pintides, pigmented, pruritic
Infectious relapses	~25%	Common	Unknown	Unknown
Late complications	Gummas, cardiovascular and central nervous system involvement	Destructive gummas of skin, bone, cartilage[b]	Destructive gummas of skin, bone, cartilage[b]	Nondestructive, dyschromic, achromic macules

[a]Sexual transmission has been recently postulated for bejel (see text). [b]Central nervous system involvement and congenital infection in the endemic treponematoses have been postulated by some investigators (see text).

Endemic Treponematoses

Oral., mucou. → gum-gangosa.

Primp papule. → pintides.



A B

FIGURE 188-3 Clinical manifestations of bejel and pinta. *A.* Mucous patches of early bejel. *B.* Pigmented macules of early pinta. *(Photos reprinted with permission from the Handbook of Endemic Treponematoses, PL Perine et al, Geneva, World Health Organization, Color Plates 54, 60, 1984.)*

Mother Yaw.

child.



A B C D

Crab yaw.

Relapses.

FIGURE 188-2 Clinical manifestations of early yaws. *A.* Primary ulcer. *B.* Secondary papillomata. *C.* Periostitis. *D.* Polydactylitis. *(Photos were taken during a yaws elimination trial in Papua New Guinea and are published with permission from Dr. Oriol Mitjà.)*

Leptospirosis

L. Interrogas (pathogenic)
L. Biflexa.

thin, coil, spiral, hooked at end.

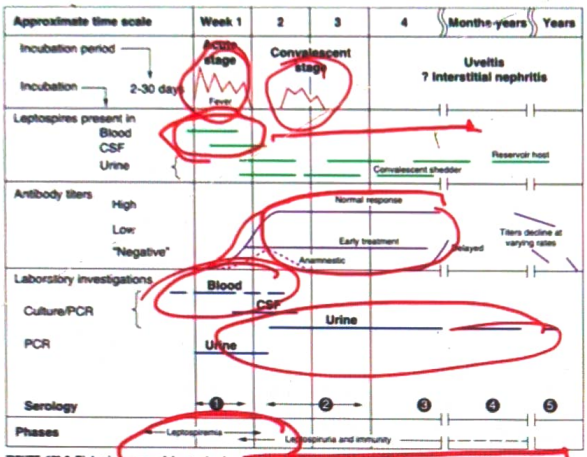


FIGURE 189-3 Biphasic nature of leptospirosis and relevant investigations at different stages of disease. Specimens 1 and 2 for serology are acute-phase serum samples; specimen 3 is a convalescent-phase serum sample that may facilitate detection of a delayed immune response; and specimens 4 and 5 are follow-up serum samples that can provide epidemiologic information, such as the presumptive infecting serogroup. CSF, cerebrospinal fluid. *(Used with permission of [ASM], from Leptospirosis, PN Levett, 14:296, 2001; permission conveyed through Copyright Clearance Center, Inc. and Turner, Leptospirosis I, Transactions of the Royal Society of Tropical Medicine & Hygiene, 61:842, 1967. Permission is granted as per the terms of the STM Permissions Guidelines. Reproduced by permission of Oxford University Press on behalf of the Royal Society of Tropical Medicine & Hygiene.)*

Leptospirosis

Severe (Weil's disease)

Pul + Renal + ~~neurologic~~ hepatic.

~~Mag~~ wasting.

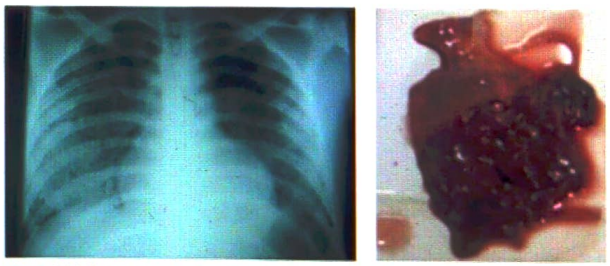


FIGURE 189-4 Severe pulmonary hemorrhage in leptospirosis. ***Left panel:*** Chest x-ray. ***Right panel:*** Gross appearance of right lower lobes of lung at autopsy. This patient, a 15-year-old from the Peruvian Amazonian city of Iquitos, died several days after presentation with acute illness, jaundice, and hemoptysis. Blood culture yielded *Leptospira interrogans* serovar Copenhageni/Icterohaemorrhagiae. *(Adapted with permission from E Segura et al: Clin Infect Dis 40:343, 2005. © 2005 by the Infectious Diseases Society of America.)*

Leptospirosis

High mortality.

>40.
AKI.
RDS.
Pul hage!
Hypoter

TABLE 189-1 Treatment and Chemoprophylaxis of Leptospirosis in Adults*

INDICATION	REGIMEN
Treatment	
Mild leptospirosis	Doxycycline† (100 mg PO bid) or Amoxicillin (500 mg PO tid) or Ampicillin (500 mg PO qid)
Moderate/severe leptospirosis	Penicillin (1.5 million units IV or IM q6h) or Ceftriaxone (2 g/d IV) or Cefotaxime (1 g IV q6h) or Doxycycline† (loading dose of 200 mg IV, then 100 mg IV q12h)
Chemoprophylaxis	
	Doxycycline† (200 mg PO once a week) or Azithromycin (250 mg PO once or twice a week)

*All regimens are given for 7 days. †Doxycycline should not be given to pregnant women or children. ‡The efficacy of doxycycline prophylaxis in endemic or epidemic settings remains unclear. Experiments in animal models and a cost-effectiveness model indicate that azithromycin has a number of characteristics that may make it efficacious in treatment and prophylaxis.

Relapsing fever

Borrelia.

1. LBRF → B. Recurrentis.
2. STRF → multiple Borrelia
3. HTRF → B. ~~miyamoti~~.

Thin. spiral.

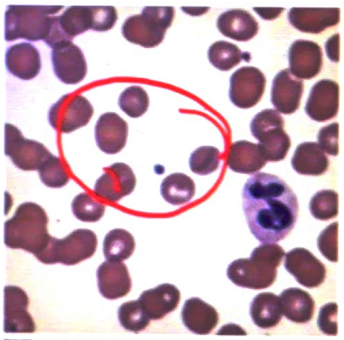


FIGURE 190-2 Photomicrograph of [illegible] in a Giemsa- Wright-stained thin blood smear. Included in the figure are a polymorphonuclear leukocyte and two platelets.

Antigenic Variation

AV1

A2 A3