18 Different Radiologic Patterns in AIDS at a Glance

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18.1 Central Nervous System

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Toxoplasmosis (<i>Toxoplasma gondii</i>)	CNS	<p>Encephalitis/leptomeningitis</p> <p>CT: Iso/hypodense (82%) lesions with surrounding edema and mass effect; contrast enhancement; well-defined, annular, nodular (rare), subependymal (rare) lesions; calcifications</p> <p>MR: Increased signal foci on long TR images with iso/hypointense centers. Short TR images: Hypointense/contrast enhancement</p>	<ul style="list-style-type: none"> • Cerebral hemispheres more frequently affected than cerebellum/brainstem • Corticomedullary junction • Basal ganglia <p>Other organs involved:</p> <ul style="list-style-type: none"> • Lymph nodes • GI tract • Respiratory tract 	AIDS-related lymphoma

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Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
AIDS-related lymphoma	CN	<p><i>(DDD) CT:</i> Multiple solid iso- or hypodense masses (less common), hyperdense heterogeneous enhancement (80%); peripheral enhancement due to central necrosis; round, oval, nodular lesions with ringlike enhancement. Linear/nodular subpial and subependymal enhancement</p> <p><i>MR:</i> Hypointense on T1WI; isointense less common; after contrast center remains hypointense; margins enhance in smooth/ringlike appearance. T2WI: variable appearances: increased, isointense or decreased signal intensity to parenchyma. If there is menigeal involvement, this is better visualized on contrast MR than on contrast CT</p> <p><i>FDG-PET imaging:</i> uptake by tumor</p> <p><i>Thallium-201 (Tl-201) brain SPECT:</i> uptake by tumor (not by infection)</p> <p><i>MR spectroscopy:</i> mild to moderate increase in lactate and lipids; markedly elevated choline peak</p>	<p>(Multi)focal lesions:</p> <ul style="list-style-type: none"> • Basal ganglia • Corpus callosum • Cerebellar vermis • Hemispheric white matter • Periventricular/subependymal <p>Other organs involved:</p> <ul style="list-style-type: none"> • GI tract • Bone marrow 	Toxoplasmosis
Cryptococcosis (<i>Cryptococcus neoformans</i>)	CNS	<p><i>CT:</i> Spherical, well-defined iso/hypodense lesion(s); cryptococcoma, gelatinous pseudocysts</p> <p><i>MR:</i> High signal on long TR images; decreased signal on short TR images; perivascular space dilatation</p>	<ul style="list-style-type: none"> • Meninges • Basal ganglia • Thalami • Midbrain • Corpus callosum • Cerebral cortex • Posterior fossa <p>Other organs involved:</p> <ul style="list-style-type: none"> • Respiratory tract • Lymph nodes • Liver/spleen • Bone marrow 	Other lesions with CNS mass effect

Organism/ disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Herpes [herpes simplex virus (HSV-1 and HSV-2)]	CNS	<p>CT: Necrotizing encephalitis; ventriculitis; necrotizing vasculitis of entire cord/spinal roots; generalized swelling, abnormal density or signal changes in white matter; cortical enhancement (rare)</p> <p>MR: Low signal intensity on T1WI, hyperintensity on T2WI. Hemorrhage can be seen (foci of increased signal intensity on T1WI)</p> <p>SPECT imaging: Increased perfusion of involved brain areas, even when CT and MR are negative</p>	<p>Diffuse involvement</p> <ul style="list-style-type: none"> • Frontal/temporal lobes • Brainstem • Cerebellum <p>Other organs involved (mucocutaneous):</p> <ul style="list-style-type: none"> • Perianal region • Oropharynx • Esophagus 	Cytomegalovirus (CMV)
Mycobacteria [<i>Myco- bacterium tuberculosis</i> , <i>M. avium intracellulare</i>]	CNS	<p>CT/MR: Leptomenigitis; meningeal enhancement of the basal cisterns; granulomata, abscess, calcifica- tions. Infarction and hydrocephalus, usually the communicating type. Parenchymal involvement (less common): ringlike, nodular lesions</p> <p>Tuberculomas:</p> <p>CT: Ring-enhancing lesions due to central necrosis ("target sign"); central calcifications or punctate enhancement, surrounded by a rim of hypoden- sity and a rim of enhancement</p> <p>MR: Granulomas are isointense on T1WI with a slightly hyperintense rim. Variable signal on T2WI. Usually mass effect and edema surrounding the tuberculoma</p> <p>MR with contrast: Intense nodular and/or ringlike enhancement</p>	<p>Solitary/multiple</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • Lymph nodes • Liver/spleen • Peritoneum • Bone marrow • GI tract • Respiratory tract • GU tract • Skin (rare) • CVS (rare) • Subarachnoid space • Subdural/epidural space • Corticomedullary junc- tion • Periventricular region • At the side of the per- forating end-arteries at the base of the brain 	<ul style="list-style-type: none"> - Toxoplasmosis - AIDS-related lymphoma - Cryptococcosis
		<p>TB abscess</p> <p>CT: Hypodense lesion with edema and mass effect; uniform, mostly thin ring enhancement; may occasionally be thick and irregular</p> <p>MR: Central pus region and liquefactive necrosis is bright on T2WI; the rim of inflammation is usually iso- to hypointense on T2WI; rim enhancement on TWI after contrast</p>	Mostly solitary	Bacterial
Varicella zoster virus	CNS	<p>Encephalitis, neuritis, myelitis, herpes ophthalmicus</p> <p>CT may be negative while MR may reveal signal abnormalities within brainstem and/or cortical gray matter</p>	<p>Diffuse</p> <ul style="list-style-type: none"> • Ganglia of cranial nerves (V, VII) 	<ul style="list-style-type: none"> • CMV • Herpes

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Brain atrophy	CNS	<i>CT/MR:</i> cortical atrophy; widened sulci	Generalized • Supratentorial (100%) • Infratentorial (70%)	—
Progressive multifocal leukoencephalopathy Papovavirus (JC virus)	CNS	<i>CT:</i> Focal white matter hypodensity without mass effect, usually without enhancement (demyelination); patchy enhancement on occasion <i>MR:</i> (More sensitive than CT) T1WI: lesions are hypointense to the parenchyma, sharply circumscribed <i>Demyelination:</i> Zones of increased signal on long TR images; decreased signal on short TR images. Lesions against corticomedullary junction, in (deep) gray matter. T2WI: hyperintense signal intensity in periventricular and/or subcortical white matter; lesions: small, but progress to larger areas of involvement. Can be unilateral. No mass effect; rarely enhancement. If enhancement is present: faint and peripheral <i>MR spectroscopy:</i> Decreased NAA and Cr, increased CHO	• Asymmetric/multifocal bilateral • Frontal, parietal, occipital region most commonly affected • Corticomedullary junction. • Periventricular subcortical • Posterior fossa (common) • Cervical cord (uncommon) Other organs involved: • Kidneys	• HIV encephalitis • HIV demyelination
Focal white matter hyperintensities	CNS	<i>MR:</i> T1WI/T2WI: zones of perivascular demyelination or dilated perivascular spaces secondary to atrophy: white matter hyperintensity	• Perivascular spaces	—
AIDS-dementia complex	CNS	<i>CT/MR:</i> Abnormal in 50%: atrophy/white matter disease <i>Iodine-123 IMP SPECT:</i> Multiple focal cortical perfusion abnormalities to be present prior to any evidence of disease on CT/MR <i>Tc-99m HMPAO:</i> Regional abnormalities of cerebral blood flow <i>FDG-PET:</i> Alternations/decrease in cerebral (subcortical) glucose metabolism	Patchy, diffuse, confluent and homogeneous	—

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Pediatric HIV infections: HIV 1-associated progressive encephalopathy	CNS	<p><i>CT/MR:</i></p> <ul style="list-style-type: none"> – Progressive atrophy and ventricular enlargement due to myelin loss or reduced myelin. – White matter hypodensity (infrequent) – Often calcifications in basal ganglia (hypointense on MR), bilaterally or in white matter of frontal lobe – Enhancement within basal ganglia <p>T2WI: hyperintensity in basal ganglia, while CT may be negative</p> <p><i>FDG-PET:</i> Diffuse or focal hypometabolism with subcortical hypermetabolism</p> <p><i>MR spectroscopy:</i> Decreased NAA/Cr ratios in subcortical structures</p>	Patchy, confluent, bilateral	Subacute encephalitis
Pediatric cerebrovascular disease	CNS	<p>HIV-related arteriopathy:</p> <p><i>CT/MR:</i></p> <ul style="list-style-type: none"> – Fusiform dilatation of circle of Willis (arteriomegaly) – Ischemia or hemorrhage may be found on contrast CT or as signal voids on T2WI 	–	–
Fibrosing sclerosis	CNS	<p><i>CT/MR:</i> Ischemic infarction</p> <p><i>MR angiography:</i> focal areas of vascular stenosis or occlusion</p>	<ul style="list-style-type: none"> • Basal ganglia • Frontal lobes 	–
HIV (subacute) encephalitis	CNS	<p>Nonspecific atrophy with deep white matter changes, without mass effect; microglial nodules undetectable by CT, but rarely seen on MR</p> <p><i>CT:</i> Areas of low attenuation</p> <p><i>MR:</i></p> <ul style="list-style-type: none"> – High signal intensity on long TR images – Combined lobal atrophy – Diffuse symmetrical white matter hyperintensity on T2WI 	<p>Diffuse, symmetrical</p> <ul style="list-style-type: none"> • Periventricular • Basal ganglia • Cortex 	PML
Acute encephalitis Acute/chronic meningitis	CNS	<i>Imaging studies</i> are usually negative; atrophy; white matter lesions less frequently seen on CT; can be seen on serial MR studies.		

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Cytomegalovirus meningoencephalitis	CNS	<p>Calcifications in neonates; microglial nodules predominantly in cortex</p> <p><i>CT:</i> Atrophy: often insensitive! usually normal – White matter hypodensity – Smooth periventricular/subependymal enhancement</p> <p><i>MR:</i> – Ventriculoependymitis; – T2WI: increased signal changes in periventricular white matter</p> <p><i>Fat-suppressed MR + Gd-DTPA:</i> – Thickened and enhancing choroid/retina (CMV retinitis) – less often: subependymal enhancement</p>	<p>Generalized/diffuse</p> <p>Other organs involved: • Respiratory system • Adrenals • GI tract • GU tract • Retina • Biliary tract • Liver/gallbladder • Hematopoietic system</p>	AIDS-related lymphoma
(Acute) syphilitic meningitis	CNS	<p>Meningovascular neurosyphilis</p> <p><i>CT:</i> Often unremarkable • Cerebral atrophy • Small infarcts due to vasculitis</p> <p><i>MR:</i> T2WI: ischemic injuries are bright • Post Gd-DTPA: enhancement in region of subacute infarction • Meningeal enhancement may be present</p> <p><i>MR angiography:</i> Vascular occlusion/narrowing on imaging studies. Gummas appear as mass lesions at the brain surface with nodular/ring enhancement, usually adjacent meningeal enhancement (vascular edema)</p>	–	–
Nocardiosis (<i>Nocardia asteroides</i> ; <i>Nocardia brasiliensis</i>)	CNS	<p>Hematogenous spread from pulmonary infection</p> <p><i>Chest radiograph:</i> Cavitary lung infiltrates are common</p> <p><i>CT:</i> Multiple brain abscesses: ring-enhancing lesions, which may be multiple or multiloculated. Meningitis: less common</p> <p><i>MR:</i> Abscess: T1WI: central low signal intensity; T2WI: high signal intensity with a surrounding capsule; extensive edema/mass effect</p>	Multiple/multiloculated	Other fungal infections: cryptococcosis, histoplasmosis, coccidioidomycosis, blastomycosis

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Bacillary angiomatosis (<i>Bartonella henselae</i> ; <i>Bartonella quintana</i>)	CNS	CT/MR: Intracerebral enhancing lesions, resembling Kaposi's sarcoma	Other organs involved: • Liver, spleen • Conjunctivae • Lymph nodes • Respiratory tract • Skeletal system: Lytic bone lesions in multiple locations	Kaposi's sarcoma
Fungal disease	CNS	<ul style="list-style-type: none"> • Acute/chronic leptomeningitis/granuloma or abscess • Subacute basilar granulomatous meningitis • Cryptococcomas <p>CT: Often unremarkable</p> <ul style="list-style-type: none"> • Atrophy • Communicating hydrocephalus <p>MR: May be negative</p> <ul style="list-style-type: none"> • Menigeal enhancement on postgadolinium images a) Parenchymal mass lesions (cryptococcomas) b) Dilated Virchow-Robin spaces c) Parenchymal/leptomeningeal nodules d) Mixed pattern <p>CT: • Hypodense lesions with solid or ring enhancement</p> <ul style="list-style-type: none"> • Peripheral small enhancing nodules (granulomas) with punctate calcifications • Small hypodensities without enhancement in basal ganglia • Cysts in basal ganglia ("gelatinous pseudocysts") 	<ul style="list-style-type: none"> • Virchow-Robin spaces in midbrain/basal ganglia • Leptomeninges 	<ul style="list-style-type: none"> • Cryptococcosis • Histoplasmosis • Coccidioidomycosis • Blastomycosis
Mucormycosis	CNS	Intracranial abscess and/or infarction	Other organs involved: • Paranasal sinuses	
Aspergillosis	CNS	<ul style="list-style-type: none"> • Vascular occlusion; hemorrhagic infarction • Focal cerebritis and abscess formation • Hypointense signal on T1WI and T2WI in the paranasal sinuses 	Focal	Other fungal infections
<i>Candida albicans</i>	CNS	<p>Meningitis, meningoencephalitis, (micro)abscess, granulomata</p> <p>CT: Granulomas: hyperdense nodules with surrounding edema and nodular ring enhancement; iso/hypodense lesions with multiple punctate enhancing nodules on contrast studies</p> <p>MR: "Target appearance": central hypointensity on T1WI and surrounding hyperintensity on T2WI</p>		Other fungal infections

DDD, Double-dose delayed; CVS, cardiovascular system; CMV, cytomegalovirus; NAA, N-acetylaspartate; Cr, creatine; CHO, choline; PML, progressive multifocal leukoencephalopathy

Organism/ disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
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18.2 Spine and Spinal Cord

Myelitis	Spine/ spinal cord	<p><i>MR:</i> Early stage: Increase in cord diameter T2WI: diffuse, ill-defined hyperintensity T1WI: poorly defined enhancement on postcontrast T1WI</p> <p><i>Later stage</i> Intramedullary abscess formation: decreased signal intensity on T2WI with well-defined ring enhancement after contrast</p>	<ul style="list-style-type: none"> • Diffuse • In association with HIV leukoencephalopathy (5%–8%) 	<p>Bacterial infections:</p> <ul style="list-style-type: none"> • <i>Staphylococcus aureus</i> • <i>Streptococcus pneumoniae</i> • Multiple sclerosis • Lyme's disease • Sarcoidosis of the spine
<i>Mycobacterium tuberculosis</i>	Spine/ spinal cord	<p>Intramedullary tuberculoma: varied appearance:</p> <ul style="list-style-type: none"> • Noncaseating granulomas: T1WI: hypointense T2WI: hyperintense, homogeneous enhancement • Caseating granulomas with solid center: T1WI: hypointense to isointense T2WI: iso- to hypointense with peripheral enhancement after contrast • Caseating granulomas with liquid center: T1WI: hypointense T2WI: hyperintense and peripheral enhancement 	10% may have brain lesions	–
Viral infections	Spine/ spinal cord	<p>Vacuolar myelopathy</p> <p><i>MR:</i> T2WI: abnormal intra medullary hyperintensity in the posterior and lateral columns of the cord, surrounding gray matter without cord enlargement or contrast enhancement</p>	<p>Associated with brain lesions</p> <p>Mid/lower thoracic spine</p>	–
Cytomegalovirus Herpes simplex virus (HSV-1/HSV-2)	Spine/ spinal cord	<p>Myeloradiculitis Polyradiculomyelitis</p> <p><i>CT/MR:</i> Often unremarkable; thickening of conus and cauda equina. Postcontrast: strong enhancement of the pia lining the cord, conus medullaris, nerve roots and leptomeningis of the cord. In case of necrotizing myelitis: <i>MR:</i> T2WI: hyperintense intramedullary lesions with contrast enhancement <i>Nonenhanced T1WI, myelography and CT myelography</i> are usually normal</p>	–	–

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Toxoplasmosis (<i>Toxoplasma gondii</i>)	Spine/spinal cord	MR: (see CNS) Focal enlargement of the spinal cord with increased T2 signal and homogeneous contrast enhancement	Coexists with brain lesions	AIDS-related lymphoma
Arachnoiditis (leptomeningitis) • Neoplastic • Inflammatory: tuberculosis	Spine/spinal cord	MR: T1WI: indistinct or absent cord outline due to increase in signal intensity of surrounding CSF. T2WI (heavily T2W FSE with fat suppression): CSF loculations and adhesions: • In the cervical and thoracic regions with obliteration of the arachnoid space • In lumbar region: nerve root fusion seen as irregularly thickened clumped nerve roots. Peripheral adherence of nerve roots to the thecal sac ("featureless or empty sac"). Contrast enhancement in lumbar arachnoiditis: 3 patterns: • Smooth linear layer of enhancement outlining the surface of the cord and nerve roots • Nodular pattern with discrete foci of enhancement, seen along the surface of the cord and nerve roots • Diffuse thick intradural enhancement which completely fills the subarachnoid space	–	• AIDS-related lymphoma • Tethered cord
Discitis/osteomyelitis	Spine/spinal cord	Disc space narrowing with osteolytic destruction of the adjacent vertebral endplates. MR: • T2WI: hyperintense discs adjacent vertebral marrow: T1WI: hypointense and T2WI hyperintense Postcontrast MR: Peripheral diffuse enhancement of the disc space and enhancement of the adjacent vertebral endplates. Paraspinal abscess	–	• <i>Staphylococcus aureus</i> • <i>Mycobacterium</i> (MAI, MTb)
AIDS-related lymphoma	Spine/spinal cord	MR: • T2WI: enlarged cord with intramedullary iso- to hyperintensity • T1WI: hypointensity; patchy enhancement after contrast administration	• Epidural • Leptomeningeal • Intramedullary Other organs involved: • Skeletal system	–

MAI, *Mycobacterium intracellulare*; MTb, *Mycobacterium Tuberculosis*

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
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18.3 Cardiovascular System

Pericardial effusion	CVS	Occurs in 10%–15% of HIV infection <i>Echocardiography:</i> Diastolic compression of the R atrium; echo-free/echo-poor space between parietal pericardium and epicardium; pericardial tamponade	Pericardium/epicardium	<i>Mycobacterium tuberculosis</i> , MAI, CMV, Coxsackie virus, herpes simplex, <i>Cryptococcus neoformans</i> , <i>Salmonella typhimurium</i> , <i>Nocardia asteroides</i> , <i>Listeria monocytogenes</i> , <i>Toxoplasma gondii</i> , Kaposi's sarcoma, AIDS-related lymphoma
Myocarditis, cardiomyopathy/ventricular dysfunction	CVS	Myocarditis (50%) and dilated cardiomyopathy (20%) Endocarditis Pericarditis/pericardial effusion Left ventricular enlargement <i>Chest radiograph:</i> Dilated cardiomyopathy with enlarged cardiac silhouette with/without pulmonary venous congestion/edema; cardiac decompensation <i>Echocardiography:</i> Four chamber enlargement with right/left ventricle hypokinesia. Abnormal septum position/motion. Marked pulmonary hypertension: both diastolic and systolic flattening of ventricular septum in response to markedly abnormal transeptal pressure gradient	Myocardium Endocardium Pericardium	<i>Mycobacterium tuberculosis</i> , MAI, CMV, Coxsackie virus, Epstein-Barr virus, herpes simplex, <i>Toxoplasma gondii</i> , <i>Pneumocystis carinii</i> , <i>Candida albicans</i> , <i>Cryptococcus neoformans</i> , <i>Aspergillus fumigatus</i> , <i>Staphylococcus aureus</i> , <i>Nocardia asteroides</i> , <i>Streptococcus pneumoniae</i> , Kaposi's sarcoma, AIDS-related lymphoma
HIV-associated pulmonary hypertension	CVS	<i>Chest radiograph:</i> central pulmonary arteries are enlarged; marked decreased in caliber peripherally; right ventricular enlargement	–	PCP

CVS, Cardiovascular system; CMV, cytomegalovirus; MAI, *Mycobacterium avium* intracellulare

Organism/ disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
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18.4 Respiratory System

<i>Pneumocystis carinii pneumonia</i>	Chest	<p>Normal chest radiograph: 10%</p> <p><i>Chest radiograph:</i></p> <p><i>Early disease:</i> Bilateral symmetric perihilar/or basal fine reticulonodular pattern without pleural effusion</p> <p><i>Advanced disease:</i> Diffuse homogeneous alveolar opacities</p> <p><i>Late disease:</i> Asymmetrically scattered alveolar consolidation (mosaic pattern); reticular pattern; thickening of interlobular/interlobar interstitial tissue</p> <p><i>Disseminated disease:</i> In patients with prophylactic aerosolized pentamidine therapy; enlarged lymph nodes; liver/spleen punctate calcifications or areas of low attenuation</p> <p>Less common:</p> <ul style="list-style-type: none"> • Miliary/coarse interstitial pattern • Thin-walled air containing cystic lesions (multiple, confluent) • Pneumatocoles: 10%–34% unilateral or less frequently bilateral • Pneumothorax (1%–6%) <p>Atypical pattern: Air space disease; cavitary nodules, hilar/mediastinal lymphadenopathy; pleural effusions (0%–2%)</p> <p><i>High-resolution CT:</i> Symmetric ground-glass appearance with a geographic distribution; pneumatocoles; interstitial pattern; sparing of lung periphery Complications: unilateral or less frequently bilateral pneumothorax</p>	<p>Diffuse; upper or lower zone predominance, sometimes focal</p> <p>Bilateral, often symmetric, multilobar</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • Liver/spleen • Lymph nodes 	Other opportunistic infections: tuberculosis, fungal infections, toxoplasmosis, HSV, Kaposi's sarcoma, CMV
<i>Staphylococcus aureus</i>	Chest	<p><i>Chest radiograph/CT:</i> Bilateral focal parenchymal opacities (wedge-shaped) with a peripheral predominance. Development of cavitations; Pleural effusions/ cardiomegaly uncommon</p>	Bilateral/focal	Other bacterial infections
Toxoplasmosis (<i>Toxoplasma gondii</i>)	Chest	<p><i>Chest radiograph/CT:</i> Predominantly coarse, nodular opacities and reticulonodular opacities; confluent consolidations; pleural effusions, occasionally lymphadenopathy (not typical)</p>	<p>Bilateral</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • CNS • GI tract (rare) 	<ul style="list-style-type: none"> • PCP • Tuberculosis • Fungal infections

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Cytomegalovirus	Chest	<i>Chest radiograph:</i> pneumonia: reticular or reticulonodular opacities; areas of consolidation; tiny nodules or symmetrically scattered alveolar opacities with preference for central lower regions; peribronchial thickening <i>CT:</i> Bronchiectasis; "tree in bud" pattern of branching; small centrilobular nodules; ground glass attenuation; reticular opacities, nodules, masses; pneumothorax; pneumomediastinum	Bilateral Other organs involved: <ul style="list-style-type: none">• Adrenals• GI tract(oropharynx)• CNS• Retina• Biliary tract• Liver/gallbladder	• PCP
Herpes simplex virus (HSV-1, HSV-2)	Chest	<i>Chest radiograph/CT:</i> Bilateral interstitial pattern; scattered focal alveolar abnormalities; pleural effusion: rare; lymphadenopathy: rare	–	• PCP • CMV
Varicella zoster virus	Chest	<i>Chest radiograph/CT:</i> Bilateral, scattered, round, nodular alveolar opacities with tendency to coalesce; pleural effusions: rare; lymphadenopathy: rare	–	• PCP • CMV
Pyogenic infections	Chest	<i>Chest radiograph/CT:</i> Diffuse heterogeneous or lobar consolidation; pleural effusions; empyema; peripheral nodules/nodular infiltrates with a basilar predominance; cavitation does occur (<i>Staphylococcus aureus</i> , <i>Rhodococcus equi</i> , and anaerobes); multiple lung abscesses may occur; intrathoracic lymphadenopathy: uncommon; may be present in <i>Rhodococcus</i> infection	Diffuse Unilateral/bilateral	• <i>Haemophilus influenzae</i> • <i>Streptococcus pneumoniae</i> • <i>Nocardia asteroides</i> • <i>Legionella pneumomae</i> • <i>Corynebacterium equi</i> (<i>Rhodococcus</i>)
<i>Strongyloides stercoralis</i>	Chest	<i>Chest radiograph:</i> May be normal miliary nodules or reticular opacities are seen. Scattered alveolar opacities and lobar consolidations may be present in patient with the hyperinfection syndrome; alveolar opacities and ARDS may develop	• bilateral	PCP
Bacillary angiomatosis (<i>Bartonella henselae</i> ; <i>Bartonella quintana</i>)	Chest	Pulmonary bacillary angiomatosis <i>Bronchoscopy:</i> Violaceous endobronchial lesions, mimicking Kaposi's sarcoma <i>Chest radiograph:</i> Parenchymal nodules most common; pleural effusions; lymphadenopathy; chest wall masses <i>CT:</i> Lymphadenopathy and chest wall masses which enhance greatly on contrast CT	Other organs involved: <ul style="list-style-type: none">• Skin• Lymph nodes• Liver/spleen• Ophthalmus, conjunctivae (rare)• Skeletal system	Kaposi's sarcoma

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
<i>Pasteurella multocida</i>	Chest	<i>Chest radiograph:</i> Focal areas of consolidation which may be complicated by cavitation and pleural effusion	Other organs involved: • Soft tissue	Other opportunistic infections
<i>Bordetella</i>	Chest	<i>Chest radiograph:</i> Interstitial infiltrates, focal areas of consolidations, occasionally cavitation	bilateral	Other opportunistic infections
Tuberculosis (<i>M. tuberculosis</i>)	Chest	Radiographic appearance of tuberculosis varies with the CD4 cell count Normal chest radiograph: 5% <i>Primary form (60%)</i> <i>Early disease:</i> >200 cells/mm ³ : typical pattern of post primary (reactivation) tuberculosis; cavitary infiltrates and consolidation usually in the apical and posterior segments of the upper lobes and /or superior segments lower lobes. Cavitation occurs. Lymphadenopathy: infrequent <i>Advanced disease:</i> <200 cells/mm ³ : Diffuse coarse, nodular, reticulonodular pattern. Cavitation occurs infrequently. Lymphadenopathy is often present, uni- or bilateral. <i>Third form (15%):</i> Miliary pattern: diffuse fine nodular pattern; focal alveolar opacities in mid/lower lung; hilar and/or mediastinal lymphadenopathy <i>CT:</i> Tuberculous lymphadenopathy: enlarged nodes with central low attenuation (necrosis) and peripheral ring enhancement on contrast CT; <50 cells/mm ³ : disseminated tuberculosis with miliary infiltrates; pleural effusions; increasing lymphadenopathy	Localized or diffuse; Unilateral or bilateral Other organs involved: • GI tract (esophagus) • Liver/spleen • Lymph nodes • GU tract • Bones • Adrenals	• PCP • Atypical mycobacterial infections • <i>M. gordonae</i> • <i>M. fortuitum</i> • <i>M. xenopi</i> • <i>M. kansasii</i> • Fungal infections • AIDS-related lymphoma
<i>Mycobacterium avium</i> complex	Chest	Normal chest radiograph: 20% <i>Chest radiograph/CT:</i> • Diffuse, bilateral, reticulonodular opacities or nodules, with or without cavities • Preference for the superior lobes; focal or diffuse alveolar disease; parenchymal consolidation miliary pattern: less common; hilar and/or mediastinal lymphadenopathy; pleural effusions	Disseminated, focal or bilateral Other organs involved: • Lymph nodes • Liver/spleen • Peritoneum • Bone marrow • GI tract • GU tract • CNS (rare) • Skin (rare) • CVS (rare)	Tuberculosis

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
<i>Penicillium marneffei</i>	Chest	<i>Chest radiograph/CT:</i> Scattered reticulonodular or alveolar opacities and/or intrathoracic lymphadenopathy (80%); single nodule/mass with/without cavitation or focal segmental consolidation (less frequent); pleural effusion; miliary pattern	Solitary/multiple lesions, bilateral, diffuse Other organs involved: • CNS • Lymph nodes • Liver/spleen • Bone marrow	• Toxoplasmosis • PCP • Tuberculosis
Nocardiosis (<i>Nocardia asteroides</i> ; <i>Nocardia brasiliensis</i>)	Chest	<i>Chest radiograph/CT:</i> • Large areas of segmental consolidations, involving several lobes • Diffuse interstitial pattern or solitary defined mass often, with cavitation; pleural or pericardial effusion may occur	Unilateral/focal Other organs involved: • CNS • Skin and soft tissue infections	• Other opportunistic infections • Tuberculosis
Histoplasmosis (<i>Histoplasma capsulatum</i>)	Chest	<i>Chest radiograph/CT:</i> Normal in 50% • Diffuse heterogeneous opacities • Diffuse small lung parenchymal nodules • Linear irregular and airspace opacities less common • Miliary pattern; focal infiltrates • Hilar/mediastinal lymphadenopathy (uncommon) • Pleural effusions (uncommon)	Disseminated More diffuse than focal Other organs involved: • Bone marrow	Other opportunistic infections
Coccidioidomycosis (<i>Coccidioides immitis</i>)	Chest	<i>Chest radiograph/CT:</i> Normal in 70% • Reticulonodular lung parenchymal opacities • Focal alveolar opacities • Discrete nodules • Hilar lymphadenopathy • Pulmonary thin-walled cavity and pleural effusion occur	Diffuse Other organs involved: • Meninges • Skin	Other opportunistic infections
Aspergillosis (<i>Aspergillus fumigatus</i>)	Chest	<i>Chest radiograph/CT:</i> • Ill-defined pleural based nodules or masses • Areas of consolidation • Multiple thick-walled cavities ("air crescent sign") in upper lobe less common: • Pleural effusions (uncommon) • Lymphadenopathy (uncommon)	Diffuse systemic dissemination (35%)	• Other opportunistic infections • Tuberculosis
Blastomycosis	Chest	<i>Chest radiograph/CT:</i> • Focal airspace opacities or masses • Diffuse nodular opacities • Cavitation • Lymphadenopathy and pleural effusions: less common	Disseminated disease	–

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Kaposi's sarcoma	Chest	<p><i>Chest radiograph:</i></p> <p><i>Early disease:</i></p> <ul style="list-style-type: none"> • Diffuse, bilateral, poorly defined, reticulonodular opacities (1–2 cm) in a perihilar distribution • Coarsening bronchovascular bundles and peribronchial cuffing • Bilateral scattered mostly round opacities, whose delineation varies in definition • Parenchymal abnormalities coarser in nature than those in PCP <p><i>Advanced disease:</i></p> <ul style="list-style-type: none"> • Lobar consolidation; Kerley B lines • Pleural effusions, mostly bilateral, often in large amounts (<40%) • Intrathoracic lymphadenopathy (30%) <p><i>CT:</i></p> <ul style="list-style-type: none"> • Ill-defined nodules; • areas of consolidation along a predominantly bronchovascular distribution; peribronchovascular thickening, radiating from the perihilar region • Subpleural nodules • Ground-glass attenuation adjacent to nodules/masses (hemorrhage) • Interlobular septal thickening (38%) 	<p>Bilateral</p> <p>Unilateral (<10%)</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • Mucocutaneous • Sternum • Ribs • Thoracic spine • GI tract • Liver/spleen • Lymph nodes <p>Pulmonary Kaposi's sarcoma is preceded in 95% by mucous membrane/skin lesions</p>	<ul style="list-style-type: none"> • PCP • CMV • NHL • Typical/ atypical mycobacterial infections • Fungal infections
AIDS-related lymphoma (B cell or T cell lymphoma)	Chest	<p>Intrathoracic involvement: 10%–50%</p> <p><i>Chest radiograph/CT:</i></p> <ul style="list-style-type: none"> • Lung parenchymal consolidation • Unilateral or bilateral solitary or multiple masses and nodules, which may rapidly progress • Pleural effusion/masses (60%); air bronchogram; chest wall invasion • Axillary/hilar/mediastinal lymphadenopathy (50%) • Less frequent: interstitial infiltrates; alveolar opacities; pericardial effusion/masses; myocardial involvement 	<p>Unilateral or bilateral; solitary or multiple lesions</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • CNS • GI tract • Liver, spleen • Pancreas • Retroperitoneum 	<ul style="list-style-type: none"> • Typical/ atypical mycobacterial infections • PCP • Fungal infections
Lymphocytic interstitial pneumonia	Chest	<p>Normal chest radiograph: 50%</p> <p><i>Chest radiograph:</i></p> <p>Nonspecific findings:</p> <ul style="list-style-type: none"> • Fine to coarse reticular/ reticulonodular interstitial opacities, • Scattered alveolar/ground-glass opacities • Pleural effusion: unusual • No intrathoracic lymphadenopathy <p><i>CT:</i></p> <p>Small nodules are the predominant findings; peribronchovascular in distribution; areas of ground-glass opacities</p>	<p>Diffuse, bilateral</p> <p>Most frequent in children</p>	<ul style="list-style-type: none"> • Other opportunistic infections • PCP

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Lung cancer	Chest	<p><i>Chest radiograph:</i> Peripheral or central nodule or mass; pleural effusion</p> <p><i>CT:</i> Lung mass, extending to the pleura</p>	–	–

HSV, Herpes simplex virus; CMV, cytomegalovirus; PCP, *Pneumocystis carinii pneumonia*; ARDS, adult respiratory distress syndrome; CVS, cardiovascular system; NHL, non-Hodgkin's lymphoma

18.5 Luminal Gastrointestinal Tract

<i>Candida</i> (<i>Candida albicans</i>)	Oropharynx/ esophagus	<p><i>Endoscopy/barium studies:</i> Oral thrush</p> <p><i>Mild disease:</i></p> <ul style="list-style-type: none"> • Edematous folds • Minimal mucosal plaques, covering a friable erythematous mucosa • Coarse filling defects, oriented along the long axis of the esophagus • Ulcerations <p><i>Moderate disease:</i></p> <ul style="list-style-type: none"> • Diffuse mucosal plaques; fine longitudinal ulcerations <p><i>Severe/advanced disease:</i></p> <ul style="list-style-type: none"> • Fold thickening • Abnormal motility • Diffuse deep ulcerations (longitudinal); "cobblestone" appearance (submucosal edema) • Extensive diffuse or focally clustered plaques ("shaggy esophagus"); barium trapping within plaques and pseudomembranes in conjunction with deep ulceration and mucosal sloughing <p><i>Endstage of disease:</i> Polypoid lesions; strictures; mucosal "bridging"</p>	<p>Focal or confluent</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • Skin • Respiratory tract • CNS 	Herpes simplex virus
Herpes simplex virus (HSV-1, HSV-2)	Oropharynx/ esophagus	<p><i>Endoscopy/barium studies:</i></p> <p><i>Mild disease:</i></p> <ul style="list-style-type: none"> • Multiple, scattered, diamond/stellate-shaped shallow ulcers, separated by normal mucosa; lucent halo of edema <p><i>Advanced disease:</i></p> <ul style="list-style-type: none"> • Diffuse nodularity/ulcerations with "cobblestoning"; inflammatory exudates • Irregular esophageal contour similar to CMV 	<p>Focal or diffuse</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • Mucocutaneous • Perianal region 	<ul style="list-style-type: none"> • <i>Candida</i> • CMV

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Cytomegalovirus	Esophagus/stomach	<p>CMV gastritis</p> <p><i>Endoscopy/esophagogram:</i> Diffuse granular mucosa, due to clustered superficial erosions and/or aphthous ulcers; irregular thickening of mucosal folds; shallow, poorly defined, diamond-shaped ulcers, irregular thickening of mucosal folds; nodular wall thickening; tiny ulcers; granularity of mucosa; narrowing of lumen with limited distensibility with attenuation</p>	<p>Distal esophagus with extension into esophagogastric junction</p> <p>Predilection: antrum</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • Adrenals • Respiratory tract • CNS • Retina • Biliary tract • Liver/gallbladder <p>Focal or diffuse: common</p>	<ul style="list-style-type: none"> • Idiopathic • HIV • Herpes • <i>Candida</i> • <i>Cryptosporidium</i>
	Small intestine	<p><i>Barium studies</i> Mild dilatation: edematous submucosal nodules (0.25–0.75cm); separation of loops; shallow or deep, round or serpiginous ulceration of various size/depth</p> <p><i>Late stage:</i> narrowing of lumen; fistula, pneumatosis intestinalis</p>	<p>Segmental or diffuse</p> <p>Predilection: terminal ileum</p>	<i>Cryptosporidium</i>
	Colon/ano-rectum	<p><i>Mild disease:</i> <i>Barium studies:</i> Diffuse mucosal granularity; cecal spasm; irregular thickening of mucosal folds (edema); superficial or deep punctate or linear ulcerations; aphthous ulcers</p> <p><i>CT:</i> Low-density edematous bowel wall; marked mucosal/serosal enhancement</p> <p><i>Severe/advanced disease:</i> <i>Barium studies:</i> Large ulcers; skip lesions; areas of mass effect (granulation tissue/submucosal hemorrhage); nodular filling defects (pseudomembranes)</p> <p><i>CT:</i> Increased density in bowel wall (hemorrhage); thickening of bowel wall</p> <p><i>Late-stage disease:</i> <i>Barium studies</i></p> <p><i>CT:</i> Narrowing of the lumen</p>	<p>Segmental or diffuse</p> <p>Common predilection:</p> <ul style="list-style-type: none"> • Ascending colon/cecum/terminal ileum • Sometimes entire colon 	

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Idiopathic HIV	Esophagus/anorectum	<i>Barium studies:</i> Giant (2 cm) well-defined flat/shallow ulceration, surrounded by thin rim of edema with surrounding normal mucosa	Usually solitary; can be multiple Predilection: lower esophagus	• CMV • HSV • Mycobacterial infection
	Small intestine	<i>Barium studies/CT:</i> "Idiopathic AIDS enteropathy"; nonspecific mild small bowel wall thickening		
Cryptosporidiosis (<i>Cryptosporidium</i>)	Small intestine	<i>Barium studies:</i> Mild small bowel dilatation; hypersecretion; "sprue-like appearance"	Diffuse Predilection: proximal bowel	Other opportunistic infections: • Giardiasis • <i>Isospora belli</i>
		<i>CT:</i> Small bowel wall thickening/ dilatation small bowel/increased intraluminal fluids; no associated mesenteric lymphadenopathy	Other organs involved: • Duodenum • Colon • Biliary tract • Respiratory tract	
<i>Mycobacterium avium-intracellulare</i> complex	Esophagus	<i>Esophagogram:</i> Focal extrinsic mass impression; longitudinal deep ulcerations; sinus tract to the mediastinum/esophago-trachial fistulae; traction diverticula; strictures in chronic disease; fistula formation	Focal Predilection: middle third of the esophagus, duodenum, small bowel	• Idiopathic HIV • CMV • <i>M. tuberculosis</i>
	Stomach/duodenal bulb	<i>Barium studies:</i> Ulceration; hypertrophic fibrotic encasement; bulky gastric mass extending into mesentery. Thickening of mucosal folds; aphthous ulcers, outlet obstruction	Other organs involved: • Lymph nodes • Liver/spleen • Peritoneum • Bone marrow • Respiratory tract • GU tract • CNS (rare) • Skin (rare) • CVS (rare)	
	Small intestine	<i>Barium studies/CT:</i> Mild dilatation with irregular fold thickening; separation/displacement of bowel loops due to low attenuation necrotic lymphadenopathy; spasm, irregularity; fine nodularity; mild hypertension with segmental/ flocculation of barium; appendiceal mass?; "pseudo-Whipple's" disease <i>CT:</i> Large mesenteric and retroperitoneal low-attenuation necrotic lymphadenopathy; marked hepatosplenomegaly	Segmental Hepatosplenomegaly common Segmental Predilection • Ileocecal area • Jejunioileum Microabscesses in liver/spleen are an uncommon finding	• Crohn's disease Other opportunistic infections: • PCP • Giardiasis • <i>Isospora belli</i> • CMV

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Kaposi's sarcoma	Colon	<i>Barium studies:</i> Circumferential thickening of cecal wall and terminal ileum; fistula formation <i>CT:</i> Regional low-attenuation necrotic lymphadenopathy	Segmental Predilection: ileocecal region Diffuse Other organs involved • Respiratory tract • Lymph nodes • Liver/spleen • CVS • GU tract • Skin	Opportunistic infections • Crohn's disease • AIDS-related lymphoma • MAC • Multiple polyps • Hematogenous metastasis
	Oropharynx/esophagus/stomach/duodenum/small bowel/colon/anorectum	<i>Barium studies:</i> <i>Early disease:</i> Flat lesions, not demonstrated on barium studies; granularity of mucosa <i>Advanced disease:</i> Irregular thickening of mucosal folds; discrete sharp mucosal nodules (6 mm–3 cm) with or without central umbilication (bull's eye/target appearance); normal intervening mucosa; nodular wall thickening or small bowel; sometimes large, bulky polypoid, segmental masses; narrowing of lumen <i>CT:</i> High-attenuation lymphadenopathy complications: intestinal perforation		
AIDS-related lymphoma	Stomach/small intestine/colon/anorectum	<i>Barium studies:</i> Diffuse wall thickening mesenteric polypoid lesions simulating adenocarcinoma; loss of mucosal pattern; irregular fold thickening; discrete Penetrating ulcers; Narrowing of lumen <i>CT:</i> Extraluminal extent of enteric lymphomas; abundant retroperitoneal or mesenteric lymphadenopathy. Acute complications: Perforation, obstruction, intussusception	Other organs involved: • CNS • Bone marrow • Abdominal viscera: kidney (hydronephrosis due to obstructing lymphnodes) • Anorectum/colon • Nonspecific hepatosplenomegaly may be present	• Kaposi's sarcoma • Mycobacterium tuberculosis

HSV, Herpes simplex virus; CMV, cytomegalovirus; PCP, Pneumocystis carinii pneumonia; CVS, cardiovascular system; MAC, Mycobacterium avium-intracellulare complex

Organism/ disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
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18.6 Liver/Spleen/Biliary tract

Pneumocystis (<i>Pneumo- cystis carinii</i>)	Liver/spleen	<p>US: Numerous nodules (liver/spleen/kidneys) Usually hypoechoic >2 cm, multiple tiny echogenic foci without shadowing</p> <p>CT: Calcifications (liver/spleen), usually hypodensity nodules, <2 cm in both liver and spleen</p>	<p>Focal</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • CNS • Bone marrow • Respiratory tract • GU tract • Adrenal glands • Retina • Thyroid • Parathyroid glands • Gallbladder • Pancreas 	<ul style="list-style-type: none"> • <i>Candida albicans</i> • <i>Aspergillus fumigatus</i> • MAC • Cytomegalo virus • <i>Mycobacterium tuberculosis</i> • Bacillary angiomatosis • Fungal infections • Kaposi's sarcoma • AIDS-related lymphoma • Smooth muscle tumor
Bacillary angiomatosis (peliosis) (<i>Bartonella henselae</i>)	Liver/spleen	<p>US: Nonspecific! Heterogeneous liver with hyper- and hypoechoic regions</p> <p>CT: Hypodense with isodense lesions after attenuation</p>	<p>Rare</p> <ul style="list-style-type: none"> • Associated with chronic diseases (malignancies, tuberculosis etc.) <p>Other organs involved:</p> <ul style="list-style-type: none"> • Respiratory tract • Mediastinum • CNS (rare) • Ophthalmic (rare) • Skeletal system 	<ul style="list-style-type: none"> • <i>Mycobacterium tuberculosis</i> • MAC • PCP • Fungal infections • Kaposi's sarcoma • AIDS-related lymphoma • Smooth muscle tumor
Fungal infections	Liver/spleen	<p>US/CT: Multiple small hypoechoic/hypodense nodules <2 cm (liver/spleen); hepatosplenomegaly</p>	<p>Diffuse</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • Respiratory tract • Bone marrow • GI tract • CNS • Lymph nodes • Liver/spleen 	<ul style="list-style-type: none"> • <i>Mycobacterium tuberculosis</i> • MAC • Bacillary angiomatosis • PCP • Kaposi's sarcoma • AIDS-related lymphoma • <i>Histoplasma capsulatum</i> • <i>Coccidioides immitis</i> • <i>Cryptococcus neoformans</i> • <i>Candida albicans</i>

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Cytomegalovirus	Liver/spleen	US/CT: Multiple focal small echogenic/hypoechoic/low-attenuation lesions	Focal or diffuse Other organs involved: • Luminal GI tract • Adrenals • Respiratory tract • CNS • Retina • Pancreas	Other opportunistic infections
	Biliary tract	ERCP: AIDS-related cholangiopathy; sclerosing cholangitis; irregular dilatation of the CBD; decreased arborization of intrahepatic ducts; irregular/“brush border” of biliary mucosa; multiple vesicular filling defects; thickened duct wall of intra/extrahepatic bile ducts; papillary stenosis; acalculous cholecystitis; extrahepatic bile duct strictures (1–2 cm)	Segmental/diffuse	• <i>Microsporidium</i> • <i>Cryptosporidium</i> • MAC • <i>Isospora belli</i> • Primary sclerosing cholangitis
<i>Mycobacterium avium-intracellulare</i> complex	Liver/spleen	US: Multiple tiny echogenic foci in liver/spleen and kidneys CT: Hypoechoic/hypodense nodules <2 cm; hepatosplenomegaly; porta hepatis and pancreatic lymphadenopathy	Diffuse/focal Other organs involved • Lymph nodes • Peritoneum • Bone marrow • GI tract • Respiratory tract • GU tract (kidneys) • CNS (rare) • Skin (rare) • CVS (rare)	• <i>Mycobacterium tuberculosis</i> • Bacillary angiomatosis • <i>P. carinii</i> (extrapulmonary) • Fungal infections • Kaposi's sarcoma • AIDS-related lymphoma
<i>Mycobacterium tuberculosis</i>	Liver/spleen	US/CT: Hypoechoic/hypodense nodules <2 cm; hepatosplenomegaly; often enlarged retroperitoneal and mesenteric lymph nodes with central necrosis (low-density nodes); concomitant segmental ileocecal thickening	Diffuse/multifocal Other organs involved: • Respiratory tract • Lymph nodes • GU tract • Adrenals • Pancreas • Bone marrow • GI tract • CNS • Soft tissue	• MAC • Bacillary angiomatosis • <i>P. carinii</i> • Fungal infections • AIDS-related lymphoma
Kaposi's sarcoma	Liver/spleen Bile duct Gallbladder	US: Small (5–12 mm) hyperechoic periportal nodules in liver/spleen Increased periportal echogenicity CT: Low-attenuation periportal lesions which enhance on delayed postcontrast scans (“prominent portal triads”); hypodense nodules <2 cm (liver/spleen); hepatosplenomegaly	Other organs involved: • Skin • Chest • GI tract • Lymph nodes • Pancreas • CVS • GU tract (kidneys)	• <i>Mycobacterium tuberculosis</i> • MAC • Bacillary angiomatosis • <i>P. carinii</i> • Fungal infections • AIDS-related lymphoma • Metastatic disease • Hemangiomas

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
AIDS-related lymphoma	Liver/spleen/ bile duct/ gallbladder	<p>Three patterns:</p> <ol style="list-style-type: none"> 1. Large infiltrating masses: US: hypoechoic, homogeneous CT: hypodense with homogeneous attenuation 2. Multiple focal nodules: US: hypoechoic CT: low density; variable size, 1–5 cm or larger 3. Diffuse infiltrating “peritoneal lymphomatosis”: US: hypoechoic CT: hypodense; mimics fluid, also with ascites <p>In all 3 patterns: Extensive retroperitoneal and/or mesenteric lymphadenopathy</p> <p>CT: soft tissue density with low central attenuation due to central necrosis</p>	<p>Other organs involved:</p> <ul style="list-style-type: none"> • Respiratory tract • CNS • Retroperitoneum (pancreas) • CVS • Luminal GI tract 	<ul style="list-style-type: none"> • <i>Mycobacterium tuberculosis</i> • MAC • Bacillary angiomatosis • <i>P. carinii</i> • Fungal infections • Kaposi’s sarcoma • Smooth muscle tumor

PCP, *Pneumocystis carinii* pneumonia; CVS, cardiovascular system; MAC, *Mycobacterium avium-intracellulare* complex

18.7 Retroperitoneum

<i>Mycobacterium tuberculosis</i>	Pancreas/adrenals	<p>CT:</p> <p>Nonspecific mass lesions: low-attenuation nodules; diffuse enlargement; retroperitoneal lymphadenopathy with central or diffuse low attenuation; peripancreatic/small bowel mesenteric, retroperitoneal/pelvic sidewalls; Fulminant necrotizing pancreatitis in patient receiving therapy with ddI</p>	<ul style="list-style-type: none"> • Pancreatic lymph nodes • Liver/spleen 	Other mycobacterial infections
<i>Mycobacterium avium-intracellulare</i> complex	Kidneys	<p>CT:</p> <p>Hepatosplenomegaly; diffuse jejunal wall thickening; soft tissue density homogeneous lymph nodes; mesangial proliferative glomerulonephritis</p>	<p>Other organs involved:</p> <ul style="list-style-type: none"> • Lymph nodes • Bone marrow • GI tract • Respiratory tract • Retroperitoneum • CNS • Skin • CVS 	<ul style="list-style-type: none"> • <i>P. carinii</i> (extrapulmonary) • <i>Mycobacterium tuberculosis</i> • Fungal infections • Kaposi’s sarcoma • AIDS-related lymphoma
AIDS-related lymphoma	Pancreas/adrenals	<p>US:</p> <p>Hypoechoic masses; lymphadenopathy</p> <p>CT:</p> <p>Lymphomatous low-attenuation masses; nodal disease; distortion of pancreatic duct; obstruction of CBD; hydronephrosis due to retroperitoneal obstructing lymphadenopathy; bulky conglomerate masses >5 cm; density is close to skeletal muscle without enhancement</p> <p><i>Ga-67 citrate</i> is useful in identifying nodes as ARL lymph nodes</p>	Disseminated disease	Kaposi’s sarcoma

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Kaposi's sarcoma	Pancreas/kidneys	CT: Focal pancreatic/kidney mass; retroperitoneal lymphadenopathy (2–3 cm); "streaky" soft tissue attenuation; infiltrations in the inguinal fat; KS nodes have a distinctive appearance on dynamic CT; brightly enhanced nodes on contrast CT	Associated with lymphadenopathy/skin manifestations	AIDS-related lymphoma
<i>Aspergillus fumigatus</i>	Kidneys	CT: abscesses	Uni/bilateral	–
Extra-pulmonary <i>P. carinii</i>	Kidneys	Renal cortical calcification: US: diffuse echogenic foci without shadowing; hepatosplenic involvement CT: diffuse punctate calcifications involving a variety of retroperitoneal structures; low-attenuation lesions AIDS nephropathy: focal segmental glomerulosclerosis US: increased cortical echogenicity with variable renal enlargement CT: hyperdense medulla; enlarged kidneys	Diffuse Other organs involved: • Adrenals • Liver/spleen • Lymph nodes	–
Cytomegalovirus	Kidneys/adrenals	Focal and segmental glomerulosclerosis; adrenal stromal tumors (leiomyoma, leiomyosarcoma)	–	–
Blastomycosis/histoplasmosis	Adrenals/kidneys	Acute postinfection glomerulonephritis	–	–
Bacillary angiomatosis (<i>Bartonella henselae</i>)	Retro-peritoneum	US: high flow on Doppler studies CT: retroperitoneal lymphadenopathy	Other organs involved: • Skin • Mediastinum • Abdomen • Skeletal system • Lymph nodes	Kaposi's sarcoma
<i>Candida albicans</i>	Kidneys	Focal renal lesions (membranoproliferative glomerulonephritis)	Liver/spleen	–

CBD, Common bile duct; ARL, AIDS-related lymphoma; CVS, cardiovascular system; KS, Kaposi's sarcoma

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
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18.8 Musculoskeletal System

Cellulitis	Skin	<p><i>Conventional radiology:</i> Cannot distinguish soft tissue/fascial layers; early osseous changes cannot be detected</p> <p><i>CT:</i> Increase in density of subcutaneous adipose tissue (90–120 HU)</p> <p><i>MR:</i> Decrease in signal intensity of fat on T1WI; increased signal intensity on T2WI, T2 gradient echo and STIR-imaging</p>	May spread to involve contiguous structures and lead to (pyo) myositis, fasciitis, vascular thrombosis, and lymphedema	–
Lymphedema (<i>Streptococcus</i> /secondary infections)	Subcutaneous layers	<p><i>CT:</i> Subcutaneous reticular or "honeycomb" pattern fibrous septa: low-attenuation (20–30 HU)</p> <p><i>MR:</i> T1WI: skin thickening; expansion of subcutaneous tissue with a characteristic "honeycomb" pattern of low signal intensity streaks</p> <p><i>STIR:</i> Serpiginous increased signal intensity in subcutaneous fat</p>	–	–
Dermatologic disorders (<i>Helicobacter cinaedi</i> , <i>Streptococcus pneumoniae</i> , secondary infections)	Skin	Eosinophilic folliculitis; pruritic papules; bacillary angiomatosis; paraneoplastic pemphigus	–	Kaposi's sarcoma
Tenosynovitis (<i>candida albicans</i>)	Tendons sheath	US/CT: edema of tendon sheath; tenosynovitis	–	–
Septic bursitis	Bursa	US/CT: edema of bursa; bursitis	<ul style="list-style-type: none"> • Olecranon • Prepatellar • Subdeltoid region 	<ul style="list-style-type: none"> • <i>Staphylococcus aureus</i> • <i>Streptococcus pneumoniae</i> • <i>Mycobacterium marinum</i> • <i>Sporothrix schenckii</i>
Myopathy	Muscular system	CT/MR: Myonecrotic muscle: enlarged, decreased attenuation; localized intramuscular collection of fluid or gas may be seen; contrast CT/MR may differentiate between normal and myonecrotic tissue	Localized/diffuse	<ul style="list-style-type: none"> • Bacterial infections (<i>Staphylococcus aureus</i>) • Fungal infections • Parasitic infections

Organism/ disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Osteomyelitis	Skeletal system	<p><i>Conventional radiography</i></p> <ul style="list-style-type: none"> • Periosteal reaction • Soft tissue swelling • Cortical erosions <p>As infection progresses: osteolytic + osteo-sclerotic changes</p> <p><i>Bone scintigraphy/MR</i> are helpful for early detection of osseous involvement and to demonstrate the extent of bone marrow infection</p>	Localized	<ul style="list-style-type: none"> • <i>Staphylococcus aureus</i> • <i>Nocardia asteroides</i> • <i>Salmonella typhimurium</i> • <i>Gonococcus</i> • CMV • <i>Candida albicans</i> • <i>Aspergillus fumigatus</i> • <i>Toxoplasma gondii</i> • Spiromycosis
Bacillary angiomatosis (<i>Bartonella henselae</i> , <i>Bartonella quintana</i>)	Skin	<p>Angiomatous cutaneous lesions</p> <p><i>Conventional radiography:</i> Osteolytic lesions with overlying soft tissue mass; periostitis</p> <p><i>Tc-99m scintigraphy:</i> Increased uptake</p> <p><i>CT/MR:</i> Intense contrast enhancement of soft tissue lesions</p>	<ul style="list-style-type: none"> • Liver/spleen • Lymph nodes • Respiratory tract • Skeletal system • Skin • Conjunctivae 	–
Tuberculosis (<i>Mycobacterium tuberculosis</i> ; <i>Mycobacterium avium-intracellulare</i>)	Skeletal system	<p>Tuberculous osteomyelitis: vertebral column/cervical spine</p> <ul style="list-style-type: none"> • Focal osteolysis with varying amounts of eburnation and periostitis • Sequestrum formation <p>Tuberculous spondylitis of thoracic/lumbar spines</p> <p><i>Conventional radiography:</i> Osteonecrosis; bone destruction involving the anterior vertebral body, narrowing of adjacent intervertebral disc; similar bone destruction of the contiguous vertebral body; progressive vertebral collapse with anterior wedging ("gibbus deformity")</p> <p><i>US/CT:</i> Psoas/paraspinal abscess</p> <p><i>Contrast MR:</i> Vertebral intraosseous abscess; meningeal involvement; subligamentous spread; paraspinal abscess</p>	<p>Other organs involved:</p> <ul style="list-style-type: none"> • Respiratory tract • Metaphyseal involvement of bones: hips/knee • Sacral bones 	<i>Staphylococcus aureus</i>

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Atypical mycobacterial infection (<i>Mycobacterium avium-intracellulare</i> complex)	Meta/diaphyses of long bones	<i>Conventional radiography:</i> <ul style="list-style-type: none"> Discrete osteolytic lesions which have sclerotic margins (osteomyelitis) Osteoporosis Abscesses/sinus tracts/sarcoma 	Multiple rather than solitary Other organs involved: <ul style="list-style-type: none"> Bone marrow Lymph nodes Respiratory tract GI tract Liver/spleen GU tract Blood Skin 	<ul style="list-style-type: none"> Tuberculosis Extrapulmonary <i>P. carinii</i> Fungal infections Kaposi's sarcoma AIDS-related lymphoma
<i>Mycobacterium haemophilum</i>	Tendon sheaths	Tenosynovitis	<ul style="list-style-type: none"> Knee Ankle Hip Digits 	—
Arthritis	Synovial joints	<ul style="list-style-type: none"> Spondyloarthropathic arthritis (Reiter's syndrome) HIV-associated arthritis; painful articular syndrome Acute symmetric polyarthritis Septic arthritis: common features, difficult to differentiate from each other Tuberculous arthritis may affect large joints: monoarticular <i>Conventional radiography:</i> Phemister's triad: <ul style="list-style-type: none"> Juxtra-articular osteoporosis Peripherally located osseous erosions Gradual narrowing of interosseous space 	<ul style="list-style-type: none"> Foot Ankle Knee Hip Multidigital dactylitis Ankle Shoulder 	<ul style="list-style-type: none"> Enteric pathogens <i>Staphylococcus aureus</i> <i>Candida albicans</i> <i>Streptococcus pneumoniae</i> MAC <i>M. kansasii</i> <i>Mycobacterium haemophilum</i>
Avascular necrosis	Skeletal system	<i>Conventional radiography:</i> Subchondral fracture; sclerosis with crescentic radiolucency; flattening of epiphyseal head; widening of epiphyseal line; rarefaction of metaphysis; preservation of joint space <i>MR:</i> Low signal intensity band or rings of involved bone T2WI: "double line" sign of adjacent low/high signal intensity	Local	—
Hypertrophic pulmonary osteoarthropathy	Skeletal system	<i>Conventional radiography:</i> Subperiosteal new bone formation; soft tissue thickening; joint effusion; clubbing of digits <i>Bone scintigraphy:</i> Increased uptake at areas of new bone formation	Local	—

Organism/disease	Organ involved	Radiologic abnormality	Extent of disease	Differential diagnosis
Spondylitis	Intervertebral (disc) space	<p><i>Conventional radiography:</i> Bony erosions of adjacent end-plates Narrowing of disc space</p> <p><i>MR:</i> T1WI: decreased signal intensity of the discs T2WI: increasing signal intensity; paraspinal/epidural inflammation; edema, abscess formation with contrast enhancement; vertebral end-plates are also affected</p>	Localized	<ul style="list-style-type: none"> • <i>Staphylococcus aureus</i> • <i>Cryptococcus neoformans</i> • <i>Candida albicans</i> • <i>Candida tropicalis</i> • <i>Pseudomonas aeruginosa</i>
Kaposi's sarcoma (KS)	Musculo skeletal system	<p><i>Plain radiographs</i> may be negative</p> <p><i>Scintigraphy</i> may be negative</p> <p><i>CT:</i> Multiple osteolytic lesions in pelvis, hips, spine, ribs, associated with periosteal reaction and overlying soft tissue mass</p> <p><i>MR:</i> Extensive edema and subcutaneous tissue changes with minimal muscle involvement; extensive muscle involvement with adjacent subcutaneous lesions</p>	<p>Multifocal involvement</p> <p>Other organs involved:</p> <ul style="list-style-type: none"> • Mucocutaneous • Sternum • Ribs • Thoracic spine • GI tract • Liver/spleen • Lymph nodes 	<ul style="list-style-type: none"> • Bacillary angiomatosis • Tuberculosis • AIDS-related lymphoma
AIDS-related lymphoma	Musculo-skeletal system	<p><i>Conventional radiography/CT:</i> Permeative osteolytic lesions with cortical destruction; sclerosis and indistinct transition zone; periosteal reaction; pathologic fractures and associated soft tissue mass</p> <p><i>MR:</i> T2WI: hyperintense signal mass</p>	<ul style="list-style-type: none"> • Lower extremities • Skull • Pelvis • Spine • GI tract • CNS 	Kaposi's sarcoma

CMV, Cytomegalovirus; MAC, Mycobacterium avium-intracellulare complex STIR; short tau inversion recovery

18.9 Different Radiologic Patterns on Chest Radiographs in AIDS

Observations	Incidence	Differential Diagnosis
Bronchial or bronchiolar wall thickening	Common	<p>Pyogenic infections</p> <p>Mycobacterial infections (MTb, MAC)</p> <p>Kaposi's sarcoma</p>
	Uncommon/absent	<p>ARL</p> <p>Viral infections</p> <p>Fungal infections</p> <p>LIP, PCP</p>

Observations	Incidence	Differential Diagnosis
Bronchiectasis	Common	Mycobacterial infections (MTb, MAC) Pyogenic infections
	Uncommon/absent	Fungal infections, PCP Kaposi's sarcoma ARL Viral infections LIP
Endoluminal polyp/mass	Uncommon	Mycobacterial infections (MTb, MAC) Fungal infections Kaposi's sarcoma ARL (rare)
	Absent	Pyogenic infections, PCP, viral infections LIP
Intrathoracic (mediastinal/hilar) lymphadenopathy	Common	Mycobacterial infections (MTb, MAC) Fungal infections ARL
	Uncommon/absent	Kaposi's sarcoma PCP Viral infections Bacterial infections
Pleural effusions (isolated)	Common	Kaposi's sarcoma ARL Bacterial infections PCP
	Uncommon/absent	Viral infections Mycobacterial infections (MTb, MAC) Fungal infections LIP
Thick-walled cavities	Common	Fungal infections (<i>Aspergillus</i> , <i>cryptococcus</i>) Mycobacterial infections (MTb, depending on CD4 cell count, MAC) Rhodococcus Septic emboli
	Uncommon/absent	PCP Viral infections Kaposi's sarcoma LIP ARL
Thin-walled cavities	Common	PCP

Observations	Incidence	Differential Diagnosis
Solitary (parenchymal) nodules	Common	Kaposi's sarcoma (peribronchovascular and subpleural) ARL Fungal infections (<i>Aspergillus</i> , <i>cryptococcus</i>) <i>Nocardia</i> Mycobacterial infections (MTb, MAC) Septic emboli Bronchogenic carcinoma
	Uncommon	CMV
Multiple (miliary) nodules	Uncommon	PCP CMV Tuberculosis Fungal infections PCP
Homo-geneous consolidation	Common	Bacterial infections Fungal infections
	Uncommon/absent	Mycobacterial infections (MTb, MAC) PCP Viral Kaposi's sarcoma ARL
Ground-glass attenuation (CT)	Common	PCP Pyogenic infections Viral infections (CMV) Kaposi's sarcoma Bacterial infections LIP
Reticular/reticulo-nodular pattern	Common	PCP Viral infections (CMV) Kaposi's sarcoma (coarse) ARL LIP
Ascites	Uncommon	<i>P. carinii</i> (extrapulmonary) ARL <i>Mycobacterium tuberculosis</i> Atypical mycobacterium Kaposi's sarcoma Bacillary angiomatosis

MTb, *Mycobacterium tuberculosis*; MAC, *Mycobacterium avium-intracellulare* complex; ARL, AIDS-related lymphoma; LIP, lymphocytic interstitial pneumonia; PCP, *Pneumocystis carinii* pneumonia; CMV, cytomegalovirus

18.10 Pathogens and Neoplasms in AIDS: Cytologic Methods

This table is adapted (and modified) from CHAN NH (1998) AIDS imaging; a practical clinical approach, Chap 6. SAUNDERS, London

Infections	Organ involved	Diagnostic method	Cytogenic staining	Pathologic characteristics
Viral infections				
Cytomegalovirus	Adrenals Respiratory tract GI tract CNS Retina	Bronchoalveolar lavage Smears FNA biopsies Transbronchial biopsies Open lung biopsies	PAP, H&E, Giemsa stain Monoclonal antibodies for immunochemistry In situ hybridization	Endothelial cells or histiocytic clusters; Enlarged large violaceous to dark red intranuclear inclusion bodies, surrounded by thin halo
Herpes simplex virus (HSV-1, HSV-2) Herpes zoster virus	Mucocutaneous Perianal region Oropharyngeal region Esophageal region	Sputum Bronchial brushing/washing (BAL) Smears from skin, oral mucosa, esophagus and remaining GI tract FNA biopsies	PAP, H&E, Giemsa stain Monoclonal antibodies for immunochemistry In situ hybridization	Vesicles/ulcerations: small esophilic, intranuclear, inclusion bodies
Bacterial infections				
<i>Mycobacterium tuberculosis</i> <i>Mycobacterium avium-intracellulare</i> complex	Lymph nodes Liver/spleen Bone marrow GI tract Respiratory tract CNS (rare) Skin (rare) CVS (rare)	Smears FNA specimen of the lymph nodes or other mass lesions Bone marrow biopsy/aspiration Bronchoscopy specimen Endoscopic biopsy	H&E stain Ziehl-Neelsen stain Kinyon stain Rhodamine-auramine stain DNA probes PAS/GMS/Giemsa stain Metaminamine stain Diff Quik	Multiple noncaseating granulomas within lobular parenchyma and portal tracts of the liver; acid fast microorganisms in cytoplasm of macrophages; single cells, small clusters, or large groups of histiocytes that are filled with small rods; inflammatory infiltrates usually absent
<i>Pneumocystis carinii</i>	Respiratory tract Liver/spleen GU tract	Induction and collection of sputum FNA biopsy of mass lesions for extrapulmonary disease Bronchial brushing/washing BAL via fiberoptic bronchoscopy FNA biopsy Sputum Smears	PAP stain: specific H&E stain: specific GMS stain Giemsa or toluidine blue stain Autofluorescence Methylene blue stain	Acellular, granular foamy alveolar casts

Infections	Organ involved	Diagnostic method	Cytogenic staining	Pathologic characteristics
Parasitic infections				
<i>Toxoplasma gondii</i>	CNS Respiratory tract Lymph nodes	Open biopsy of enlarged regional lymph nodes FNA or tissue biopsy of intracranial mass BAL Smears	Giemsa stain H&E stain PAP/PAS stain GMS stain Monoclonal antibodies with immunoperoxidase stain Cannot be cultured; morphologic identification is crucial	<i>Toxoplasma</i> cysts three morphologic forms: • tachyzoites (acute infection: 3–7 mm × 2–4 mm tear drop, crescent shape; groups or aggregates within membrane, round cytoplasmic vacuoles; oval or rounded) • Bradyzoites (chronic infection): rounded, packed tightly into cysts (30–100 mm) • Oocysts: contain up to eight sporozoites
<i>Cryptosporidium</i>	GI tract Biliary tract Respiratory tract	–	Ziehl-Neelsen stain	Acid-fast micro-organisms (2–6 µm)
<i>Microsporidium/ Isospora belli</i>	GI tract (small bowel) Lymph nodes			Electron microscope examination

Fungal infections

<i>Candida albicans</i>	Skin Oral cavity Esophagus Respiratory tract	Endoscopy specimen Bronchoscopy specimen	PAP/PAS stain GMS stain Culture Tissue immunohistochemistry or DNA probes not necessary	Invading fungi surrounded by granulocytes; buds and pseudohyphae without branching or true septations
Histoplasmosis (<i>Histoplasma capsulatum</i>)	CNS Respiratory tract Liver/spleen Adrenals Kidney	FNA biopsy of mass lesions BAL Peripheral blood smears	PAP/PAS stain Giemsa stain GMS stain Bone marrow culture Tissue immunohistochemistry or DNA probe not necessary	–
Cryptococcosis (<i>Cryptococcus neoformans</i>)	CNS Lymph nodes Liver/spleen Bone marrow	Lumbar puncture (CSF) FNA specimen of a mass lesion Skin biopsy	PAP stain PAS stain GMS or mucicarmine stain India ink stain (CSF)	Epithelioid, multinucleated giant cells with organisms in their cytoplasm; small, sometimes teardrop-shaped budding yeasts with a diameter of 4–7 µm. Cells have prominent capsules
Coccidioidomycosis	Respiratory tract CNS	BAL Transbronchial biopsy	PAP stain PAS stain GMS or mucicarmine stain India ink stain (CSF)	

Infections	Organ involved	Diagnostic method	Cytogenic staining	Pathologic characteristics
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Neoplasms

Kaposi's sarcoma	Skin Mucous membrane Bronchial tree Oropharynx GI tract Lymph nodes Liver CVS GU tract (kidneys)	Endoscopy Biopsy	FNA biopsies Cytology plays no role in diagnosis	Five patterns are recognized: early, nodular, aggressive cutaneous, lymphadenopathic, and systemic generalized Kaposi's sarcoma <i>Histology:</i> Early angiomatous spindle cell, inflammatory, mixed and pleomorphic variant <i>Early lesions:</i> Small red nodules: 1–2 mm, later macular plaque-like lesions; slight to moderate cytonuclear pleomorphism with mitoses. Tumor cells show erythrophagocytosis, perivascular growth. Reactive proliferation of endothelial cells; irregularly dilated vascular spaces coated with swollen endothelial cells, similar to HHV-8
AIDS-related lymphoma	Respiratory tract GI tract CNS Pleura Pericardium Peritoneal cavity	FNA biopsy of mass lesions Smears	H&E stain Diff Quik Ziehl-Neelsen stain Giemsa stain Gram stain AFB	Pleomorphic population of lymphocytes, plasma cells and macrophages in a clear background, without granulomas or necrosis. Mixed cellularity. <i>Histology:</i> • Centroblastic cells • Lymphoblastic cells • Immunoblastic cells

FNA, Fine-needle aspiration; PAP, Papanicolaou stain; H&E, hematoxylin and eosin stain; GMS, Grocott's methenamine silver stain; PAS, periodic acid-Schiff stain; CSF, cerebrospinal fluid; AFB, acid-fast bacilli; BAL, bronchoalveolar lavage; CVS, cardiovascular system