Pediatric TB radiographs
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Radiology

- Best quality frontal and lateral views of the chest
- Reading by experienced pediatric radiologist
- Avoid overreading –
  » If questionable – consider other infection, reactive airways disease –
  » Treat other causes if feasible and then repeat
  » Avoid CT scans (diagnose subradiographic nodes)
Pediatric TB Radiology

- Airspace disease / parenchymal infection
- Lymphadenopathy
  » Hilar; paratracheal; mediastinal; subcarinal
- Atelctasis / collapse-consolidation
  » Endobronchial TB
- Pleural disease
- Miliary disease
- Cavitation – more likely in adolescents

NOT TB

- Calcified granulomata OR pulmonary vessels on end
- Isolated calcified lymph nodes
- Isolated pleural thickening
- Most “peribronchial thickening”
- Most “hilar fullness” not confirmed on lateral
Isolated calcifications without parenchymal changes or enlargement of lymph nodes is LTBI. It is not TB disease.

Isolated pleural thickening without parenchymal changes or Pleural effusion is LTBI. It is not TB disease.
Right upper lobe consolidation – likely right hilar node

Likely lymph node
Thymus or lymph node?
Thymus or lymph node?

Lymph node behind thymus

Hilar nodes
Hilar nodes
Lymph nodes in the hilum or mediastinum are seen as fullness in the infrahilar window.
Look at the position of the airway. The trachea is normally to the left side of midline. When there is a right paratracheal node, the trachea gets pushed to the midline or even toward the left as in this case.
Primary complex disease

Proximal lymph node

Parenchymal focus

Primary complex disease
Left upper lobe infiltrate, left hilar nodes
Patchy right sided disease

Collapse-consolidation
? Bronchogenic spread
Diffuse patchy changes suggest bronchogenic spread

Collapse-consolidation

Miliary TB
Cavitary TB
In an adolescent

Scrofula

- Enlarging nodes
- Not particularly painful
- Skin becomes dusky and thin over time
- May eventually suppurate and drain

Differential diagnosis: bacterial; cat scratch disease, nontuberculous mycobacteria (NTM)
Scrofula

- More likely to be TB:
  - Cervical chain
  - Slightly older child
  - Exposure to TB
  - Consistent demographics
  - Larger TST reaction
  - (In my experience:) responds beautifully to TB therapy

Scrofula management

- Skin test child & family
- If most likely TB – treat empirically
- If most likely CSD - aspirate if very large and suppurative (rare treatment)
- If most likely NTM – seek complete excision with AFB culture and path
  - If unable to completely excise – consider clarithromycin, rifampin & ethambutol
Positive skin test in patient and sister suggesting TB rather than another etiology

2 year old twin dx with TB

» 2 year old twins diagnosed with active TB
» Started on INH / RIF / PZA
» PZA stopped at two months
» Source case found late (slept in same bed) – INH resistant
CC May, 2001
beginning of therapy
2 year old twin dx with TB –tx with 3 drugs

CC August, 2001
PZA discontinued
CC  November, 2001 – CXR worse, poor weight gain; EMB and levofloxacin added

Source case belatedly found and is INH resistant

CC  February, 2002
What do we do now?
eventually, gradually improved
UH - Another case

- 2 month old baby – mother diagnosed with pleural TB (pan-sensitive)
- TST negative; CXR negative
- Started on INH for window prophylaxis
- INH stopped after three months – no repeat TST
- Six weeks later:

Gastric aspirate grew INH resistant M.tb
Gastric aspirate grew INH resistant M.tb

What to do now?

- Gastric aspirates for culture
- VERY high yield in young infants
- Four drug TB therapy
UH

- Culture grew INH resistant *M. tb*
- RFLP showed different isolate than mother’s
- Grandfather diagnosed following year with INH resistant TB

UH – lessons learned

- Exposed children should be followed
  - By medical provider
  - By Public Health (Directly Observed Therapy)
- Three months after exposure ends AND when the child is at least 6 to 12 months of age: Repeat the TST before stopping therapy
- Beware the second source case
Another case: RN

- 9 year old – screened because mother dx active TB
- Positive TST
- CXR questionable for hilar adenopathy
- CT obtained
No hilar adenopathy; small airspace abnormality (arrow): “nonspecific RUL peripheral subsegmentalatelectasis/scarring/infiltrate”
RN

- CT read as no hilar adenopathy
- BUT - ??? Tiny area of infiltrate vs. atelectasis
- Decision made to start INH and watch
- Repeat CXR in three months
Pleural thickening

- Resident in clinic wanted to continue to follow her
- Added rifampin and pyrazinamide to INH
- Turns out no cultures got to lab from mom
Increasing pleural disease
Surgical biopsy revealed INH resistant M. tb

She did beautifully on RIF, PZA, EMB

Siblings also treated for INH resistant LTBI

Lessons learned

- Completely evaluate adult source cases
- Do not start INH alone if active TB is considered
- Review all films together
  » (CT and plain film both show small airspace abnormality)
Lessons learned (2)

- If possible:
  - Treat patient in dedicated TB clinic
- If lesion increased on INH alone, likely resistant
  - INH kills first 95% of organisms
  - Children rarely have enough organisms to induce resistance

Another patient: RG

- 17 month old
  - Fever without source for two weeks
  - Some sweats, no respiratory symptoms
  - Evaluated with blood work, TST by MD
  - TB skin test not read
  - Fever eventually subsided
**RG**

- During routine follow-up, PMD notes that TST not read and repeats it
- TST now 25 mm
- Mother swears that this is different

**What to do?**

- Chest radiograph, PA, and lateral
- Physical exam
- History
- Source case investigation
Diffuse miliary pattern, upper zonal predominance; right paratracheal mass, mass effect on trachea to left

Evaluation for disseminated TB

- Gastric aspirates
- Mycobacterial blood cultures
- Lumbar puncture
  - Large volume for AFB smear, culture, and PCR
- AFB urine culture
## Another patient: MH

- 4 ½ year old
- 16 mm TST on school screening
- Asymptomatic, exam normal
- Chest radiograph moderate right adenopathy
- Mother and few close contacts TST negative
- No source case found

## MH (2)

- Gastric aspirates culture negative
- Started on four drug TB therapy
- At one month visit, mom reported increased appetite and energy
- At two month visit – some new fever
“Marked increase in right hilar adenopathy; segmental infiltrate right lower lobe.” Infiltrate and airway appearance suggest obstruction.
MH – what to do?

- Review:
  - Adherence – nurse had begged to d/c DOT
  - Ingestion – swallows whole dose
  - Absorption – no reason for concern
    - (HIV negative, no diarrhea, weight good)
  - Resistance – still no source case found

MH – what to do? (2)

- Bronchoscopy done – caseous material, cultures negative
- Other causes of endobronchial granulomatous disease considered
- Steroids, quinolone, and streptomycin added
MH – what to do? (3)

- One month later, increased infiltrate – presumed to be post-obstructive;
- Treated with steroids and azithromycin
- I usually treat post-obstructive pneumonia with steroids and augmentin to cover mouth flora

MH - what to do? (4)

- Marked clinical improvement!!!
- Two and ½ weeks off azithromycin
Increased infiltrate again!

MH – what to do?

- Much discussion about next step
  - Stop TB therapy and do invasive biopsy OR
  - Restart azithromycin (associated with clinical improvement)
- Others voted to try empiric therapy (single drug to failing regimen)
MH – what to do?

- Family wanted to restart azithromycin and watch carefully

Improved!!
Continued improvement on therapy appropriate for NTM

Lessons learned

- Stop TB therapy for several days before bronchoscopy/biopsy if possible
- Not everything is TB – (mother and all contact TST negative)

This was very likely nontuberculous mycobacteria
Lessons learned

- Stop TB therapy for several days before bronchoscopy/biopsy if possible
- Not everything is TB – (mother and all contact TST negative)

This was very likely non-tuberculous mycobacteria

Another patient: BC

- 22 month old previously healthy boy
- 5 months of intermittent wheezing
- Wax and wane cough, wheeze, congestion
BC Social History

- Parents smoke outside
- No daycare
- Grandmother (Korean) helps care for him.
- Father & 4 yr old sib all well
- 2 dogs

TST 10 mm
Subcarinal mass with focal effacement or infiltration of left mainstem bronchus and left hilar adenopathy.
COURSE

- Whole family skin tested – negative
- Medical therapy deferred
- Patient’s respiratory symptoms have resolved
- Culture positive for Mycobacterium avium complex

Another patient: AA

- 8 month old Cambodian boy
- History of reactive airways disease and atopy
- Series of ER and urgent care visits for respiratory symptoms
What things make it more likely that a respiratory illness in a child is TB?

- High fever and acute onset of symptoms
- Radiographic findings more impressive than clinical symptoms / physical findings
- Enlarged mediastinal lymph nodes on CXR
- Wheezing / crackles on exam
- History of family with TB risk factors

Choose three answers
What things make it more likely that a respiratory illness in a child is TB?

- High fever and acute onset of symptoms
- Radiographic findings more impressive than clinical symptoms / physical findings
- Enlarged mediastinal lymph nodes on CXR
- Wheezing / crackles on exam
- History of family with TB risk factors
What’s your next step for this child?

- Take a good history and physical and:
  - start TB therapy
  - Consider TB by asking about exposure risks, potential source cases and place a TB skin test
  - Collect cultures for TB
  - Treat other potential diagnoses like asthma and/or community acquired pneumonia
  - Repeat a chest radiograph in a few weeks

Choose three answers
Clinically and radiographically

Positive TB skin test

**Clinically and radiographically**

- Normal
  - Consistent with TB
    - Treat for LTBI
  - Abnormal
    - More consistent with other diagnosis
      - Patient very stable?
        - NO
          - Collect cultures and start 4 drug TB therapy
        - YES
          - Consider culture collection (NO INH!!!) Treat other diagnosis

- Other diagnosis confirmed, Course inconsistent with TB
  - TB still possible?
    - Reassess weekly

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*** Cultures only help if they are positive***

Bronchial inflammation with LLL atelectasis/infiltrate
What’s your next step for this child?

- Take a good history and physical and:
  - start TB therapy
  - Consider TB by asking about exposure risks, potential source cases and place a TB skin test
  - Collect cultures for TB
  - Treat other potential diagnoses like asthma and/or community acquired pneumonia
  - Repeat a chest radiograph in a few weeks

Choose two answers
What’s your next step for this child?

- Take a good history and physical and:
  - start TB therapy (after cultures)
  - Consider TB by asking about exposure risks, potential source cases and place a TB skin test
  - Collect cultures for TB (first)
  - Treat other potential diagnoses like asthma and/or community acquired pneumonia
  - Repeat a chest radiograph in a few weeks

Increasing narrowing of the left main stem bronchus; possible hilar adenopathy
Increasing narrowing of the left main stem bronchus; possible hilar adenopathy
Infectious disease consulted

- Diagnosis of TB made
- Source case investigation revealed:
  - Mom had pleural TB
  - Family friend had 4+ smear positive TB
  - Three children had active TB
  - Everyone else had LTBI
  - Subsequent secondary case in adult

How are you going to treat this child?

- Isoniazid suspension 5 mg/kg/day
- Isoniazid tablets 10 – 15 mg/kg/day
- Rifampin capsules 10 – 15 mg/kg/day
- Rifampin suspension 10 – 15 mg/kg/day
- Pyrazinamide 20-40 mg/kg/day
- Pyrazinamide 25 mg/kg/day
- Ethambutol 15 – 25 mg/kg/day
How are you going to treat this child?
By Directly observed therapy!!

- Isoniazid suspension 5 mg/kg/day
- Isoniazid tablets 10 – 15 mg/kg/day
- Rifampin capsules 10 – 15 mg/kg/day
- Rifampin suspension 10 – 15 mg/kg/day
- Pyrazinamide 20-40 mg/kg/day
- Pyrazinamide 25 mg/kg/day
- Ethambutol 15 – 25 mg/kg/day

Better on treatment
Lessons learned

- Persistent respiratory symptoms may be TB – and not asthma, virus, etc.
- If you tell the radiologists you are considering TB – more likely to make the diagnosis
- TB risk factors:
  » Foreign born, foreign travel, exposed to foreigners, TST positive or TB dz in house
Another patient: JY

- Cousin of AA
- TST 15 mm
- 3-4 days fever and cough
- CXR initially read as normal – subsequently read by radiologist

Possible left hilar adenopathy
Possible left hilar adenopathy
What things make it more likely that a respiratory illness in a child is TB?

- High fever and acute onset of symptoms
- Radiographic findings more impressive than clinical symptoms / physical findings
- Enlarged mediastinal lymph nodes on CXR
- Wheezing / crackles on exam
- History of family with TB risk factors

What’s your next step for this child?

- Take a good history and physical and:
  - **start TB therapy (after cultures)**
  - Consider TB by asking about exposure risks, potential source cases and place a TB skin test
  - **Collect cultures for TB (first)**
  - Treat other potential diagnoses like asthma and/or community acquired pneumonia
  - Repeat a chest radiograph in a few weeks

Because this child is a TB contact – you start Tx NOW
JY

- JY had increasing respiratory symptoms and was reevaluated by radiograph

Left upper lobe pneumonia or atelectasis
Good questions to ask when possible worsening:

- Is the patient getting every TB dose (DOT)?
- Is there any possibility of drug resistance?
- Is it possible the diagnosis is wrong (not TB)?
- Is the patient gaining weight and generally improving?
- Could there be drug interactions or another medical condition (malabsorption) which leads to low drug levels?

Interval development of air trapping with mediastinal shift
What happening on this CXR?

- Left upper lobe collapse only
- Enlarging hilar lymph node compressing left mainstem bronchus
- Air trapping left lower lobe / ball valve phenomenon causing shifting of the mediastinum
- Right sided infiltrate only

Choose two answers
Interval development of air trapping with mediastinal shift

What should you do next?

- Surgery to relieve the obstruction
- Collect cultures and add two more TB drugs
- Steroids to shrink the lymph node enlargement

Choose one
What should you do next?

- Surgery to relieve the obstruction
- Collect cultures and add two more TB drugs
- Steroids to shrink the lymph node enlargement

Much improved after steroid use
Lessons learned

- Read radiograph more aggressively for:
  - Exposure to TB
  - Symptoms of TB

- Endobronchial TB:
  - Post-obstructive pneumonia
  - Ball-valve air trapping
  - Bronchogenic spread

Another patient: JD

- 15 month old girl
- Bullous pemphigus skin disease
- Treated with Cellcept and prednisone
- One month of cough and anorexia
- Six pound weight loss
Visceral calcifications
Visceral calcifications

Nephroma
JD

- LUL infiltrate
- Fibrosing mediastinitis with calcifications
- Large, fatty liver
- Multiple masses in kidneys
- Generalized body wall edema
- ...  

What to do?

- Make a diagnosis!!!
- Broad differential includes malignancy, TB and other opportunistic infections
**JD**

- History:
  - Dad had been treated for active TB before JD was born
  - Rest of family was TST positive, but treated for 6-9 months with INH

**JD (2)**

- More history
- Dad had a friend who developed TB after JD was born
- Their “friendship” was not initially known to public health
- Two different PHNs
- “Oh, that household is taken care of”
• More history
  » In fact mom and other kids took very little of their LTBI treatment
  » Every time PHN there to monitor: “Oh, I left the bottle at grandmas …”

Completion of therapy radiograph
### Evaluation of the newborn

- If the mother has LTBI and there are no household contacts with TB, no evaluation or treatment for baby needed
- If the mother has TB
  - Examine the baby
  - Obtain a chest radiograph
  - Examine the placenta

### Congenital TB

- Exceedingly rare
  - Increased risk during maternal primary infection, disseminated disease, or genitourinary disease
  - Associated with hematogenous infection, aspiration or ingestion or amniotic fluid
- Postnatal acquisition more frequent
Features of congenital TB

- Fever
- Irritability
- Poor feeding
- Skin lesions (papule / pustule / vesicle)
- Liver and/or spleen enlargement
- Enlarged lymph nodes
- Cough or increased work of breathing
- Various chest radiographic abnormalities

Diagnosis of congenital TB

- Rule out other causes of sepsis and congenital infection
- Diagnosis frequently precedes maternal diagnosis
- Frequently smear and culture positive on gastric aspirates
- Obtain spinal fluid
Treatment of newborn

- Congenital TB - treat based on maternal drug susceptibility pattern or empiric 3 – 4 drug regimen
- Normal exam and radiograph
  - INH unless mother is very clearly no longer contagious and no second source case
  - Treat 3 – 9 months and then place a TST
  - Reunite mother and baby as soon as INH tolerated

Another patient: KH

- 10 year old Ethiopian adoptee
- Treated for smear positive TB in Ethiopia (no cultures)
- Initially, lack of clinical improvement
- Seizure in Ethiopia
Another patient: ME

- 8 month old Ethiopian adoptee
- Screened with TST – positive
- Serial respiratory illnesses in Ethiopia
- Thriving in US home
Hilar lymph node
Swelling seen on lateral
● Culture grew MDR-TB
● Patient treated with five drugs to which the isolate is susceptible

Improved on therapy
Another patient VC

- 5 month old asymptomatic VC (sister of index case), TST 8 mm, has an abnormal chest radiograph
- Upon further questioning:
  - 3 days of minimal cough
  - 2 days of decreased appetite
  - 1 day of fever
  - no URI symptoms

Right sided disease
Much improved on therapy

Conclusions

- Not every child with a positive TST / abnormal radiograph has TB
- Try to culture the sputum / gastric aspirate
  - Less than 50% will be positive for TB
  - A negative TST / culture does not rule out TB
- Start therapy as soon as cultures are collected
  IF suspicious CXR / TB exposure risks
- DOT!!
Conclusions

- If the patient has clinical or radiographic worsening:
  - Evaluate adherence to therapy
  - Consider possibility of drug resistance / other diagnosis / low drug levels (check doses)
- Consider steroids / antibiotics for obstructive phenomenon if confident of dx and TB susceptibility