KK Women's and Children's Hospital
SingHealth

Complicated Pneumonia Assessment and Management

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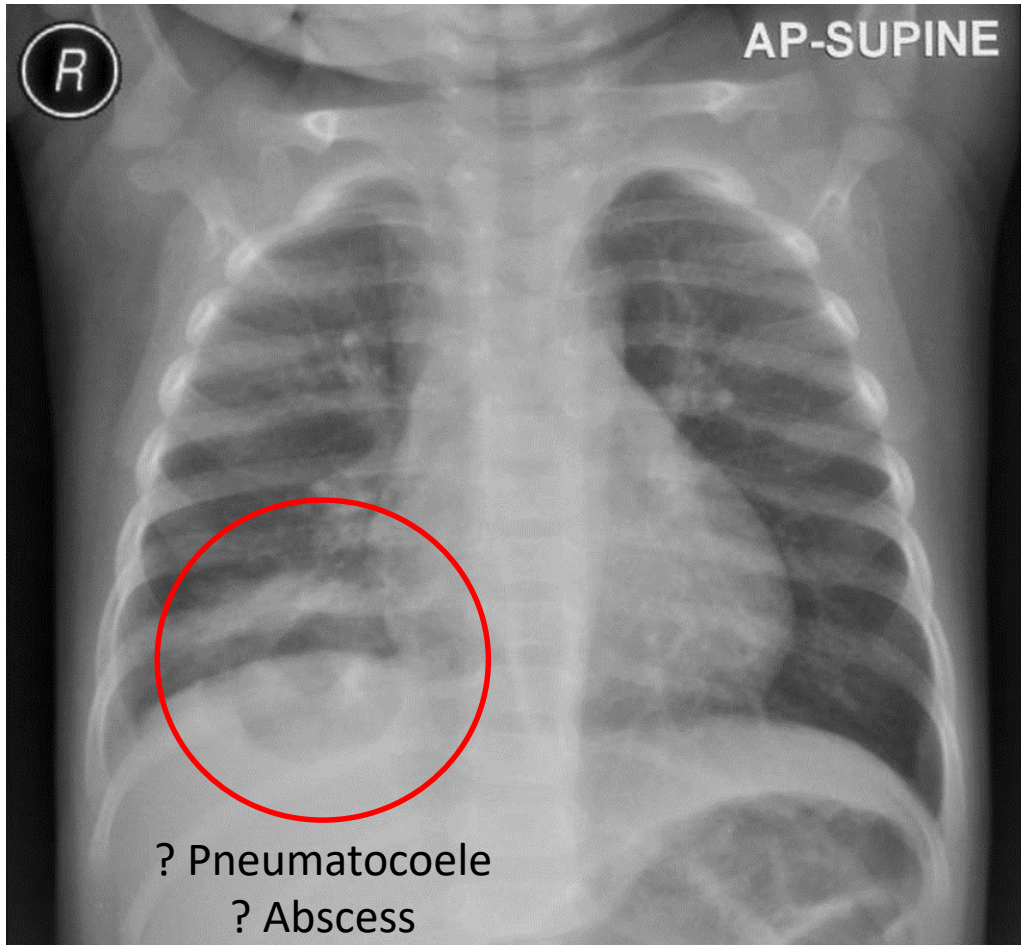
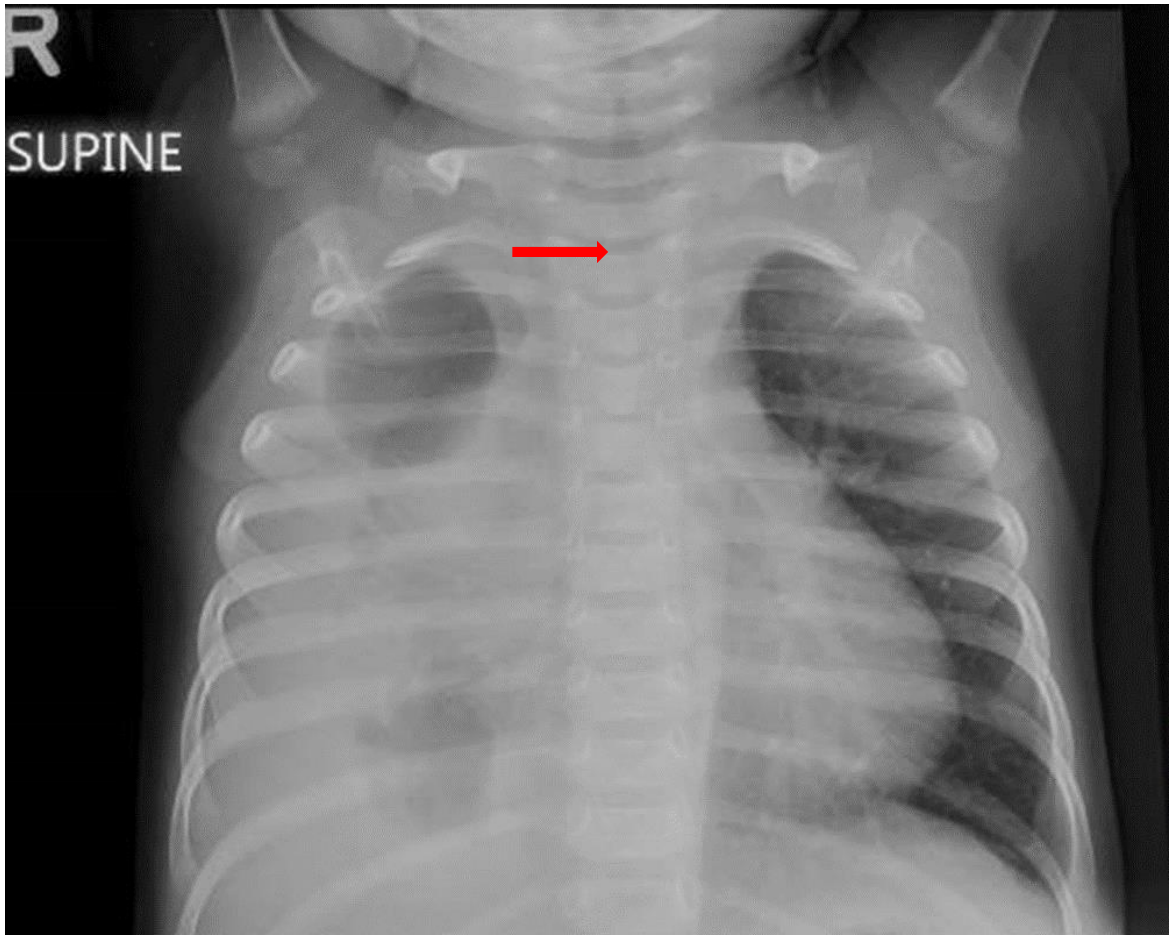
Case 1

- 1 year 1 month female
- Fever 5 days, cough 10 days
- Seen by doctor in home country
  - Chest X ray done
  - Treated with cefaclor and flucloxacillin
- Admitted on same day by paediatrician in Singapore
  - Started on oral Augmentin then IV ceftriaxone
- What do you see?



Case 1

- Fever persisted
- Rashes on body and limbs noted for a few days – resolved
- Developed tachypnea – started on CPAP
- Transferred to KKH
- Chest X ray repeated
- What do you see?
- What would you do?



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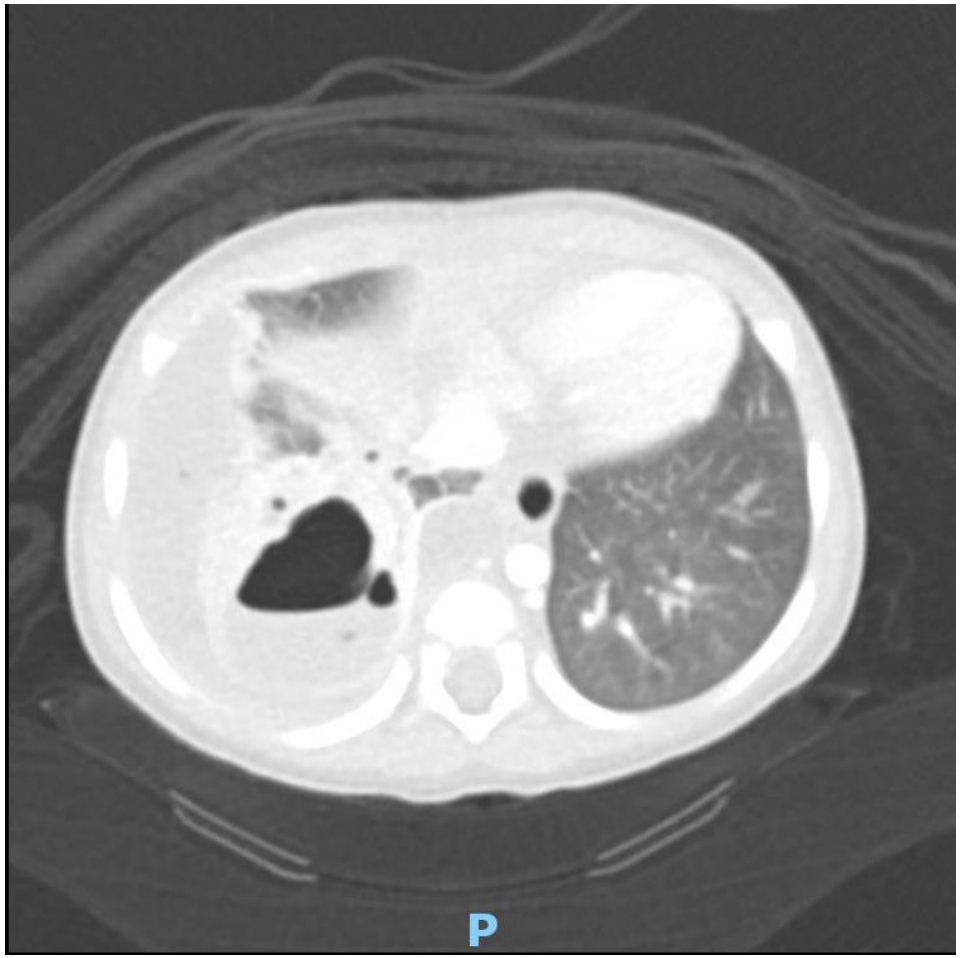
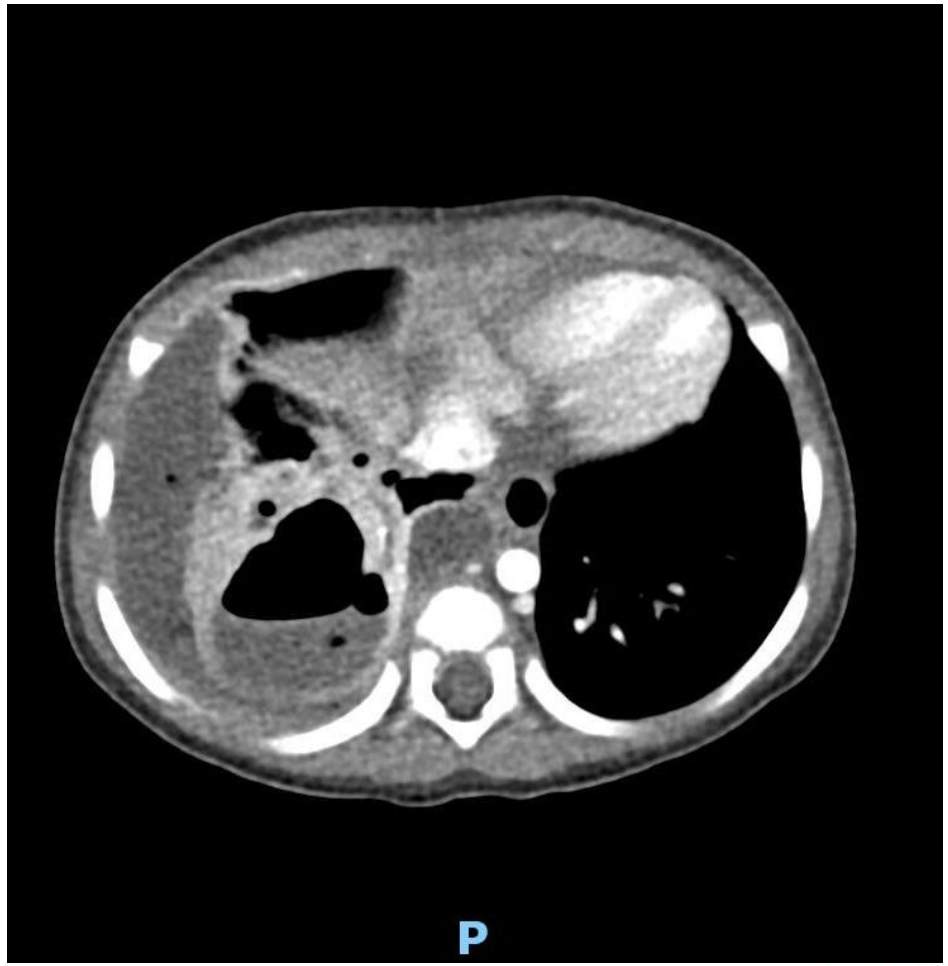
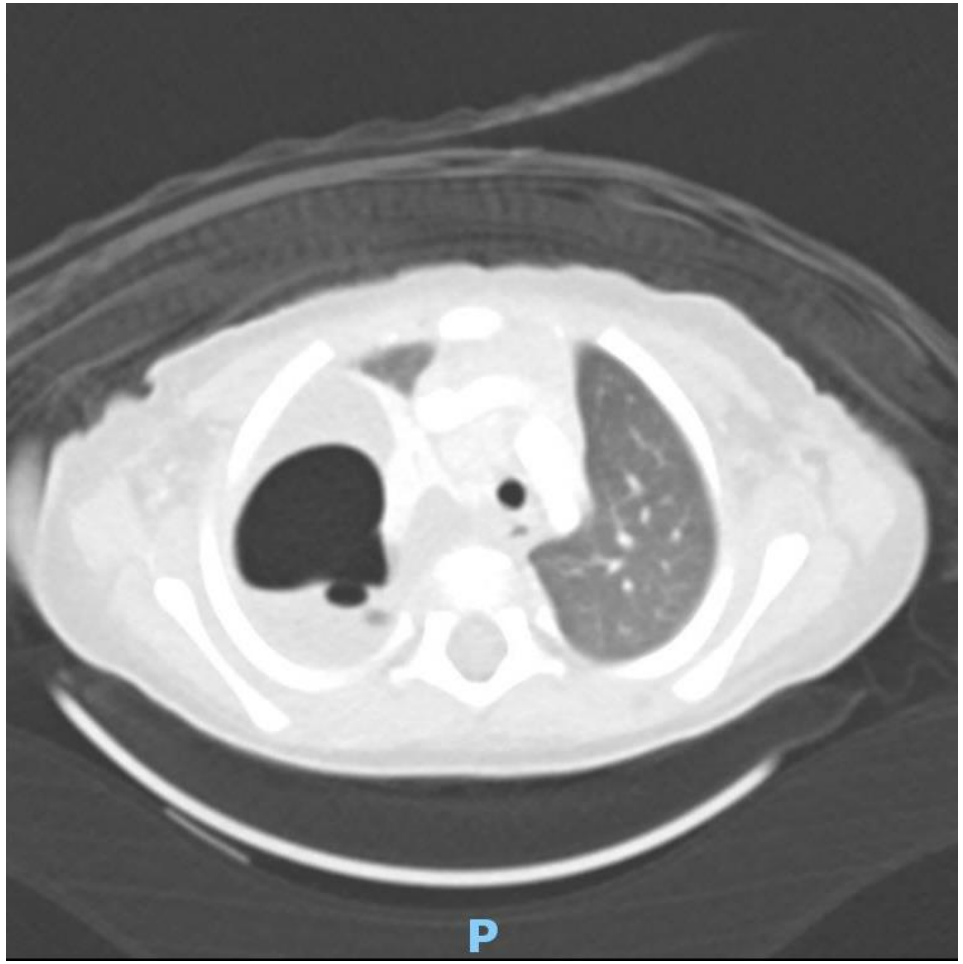
Case 1 – CT Thorax (Axial)

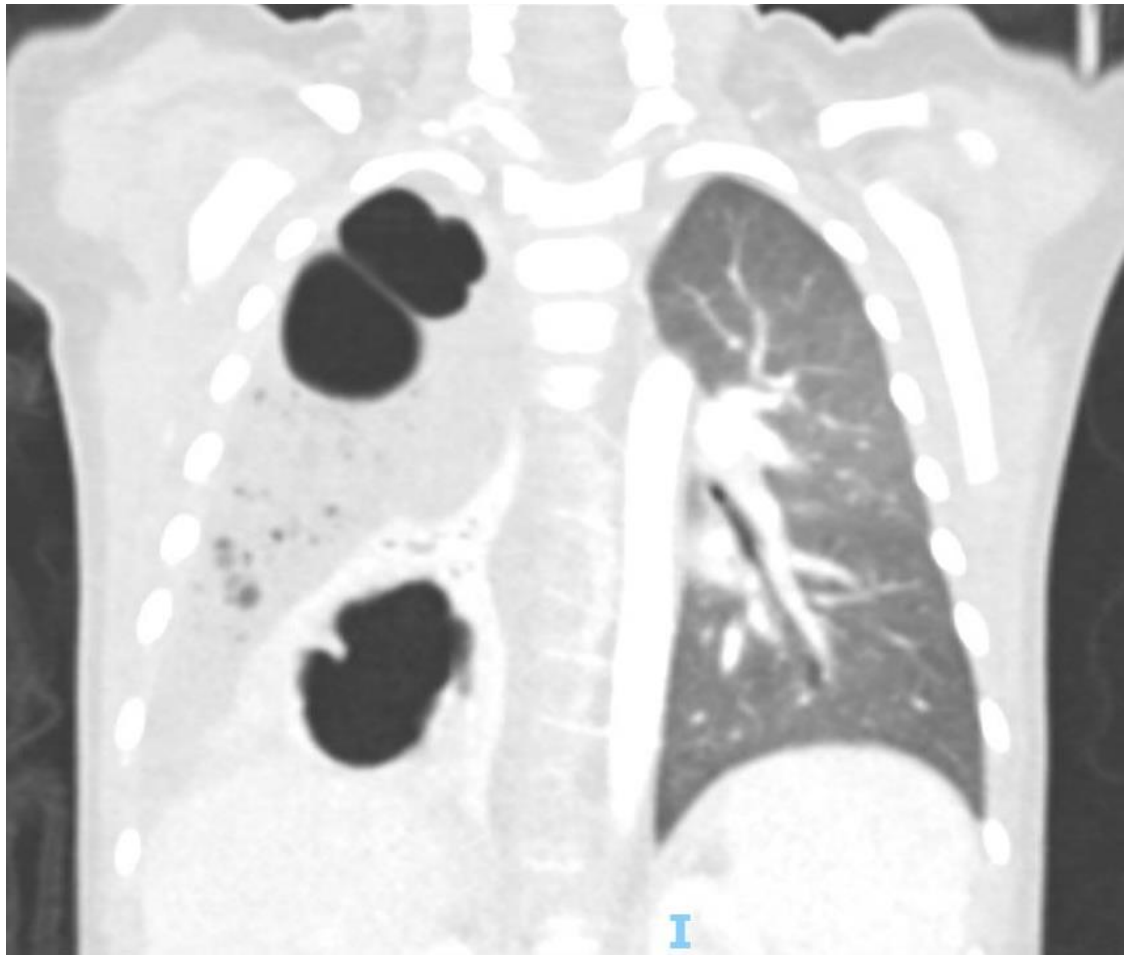




Case 1 – CT Thorax (Axial)



Case 1 – CT Thorax (Coronal)



Case 1

- What would you do next

- Referred to paediatric surgeon for video assisted thoracoscopic surgery (VATS)
  - Right sided loculated empyema
  - Thick gelatinous peel over parietal pleura and lung surface and within oblique fissure causing entrapment of underlying lung
  - Seropurulent fluid within pleural cavity seen and frank pus noted around area of lower lobe cavitating lesion

- Pleural fluid culture?

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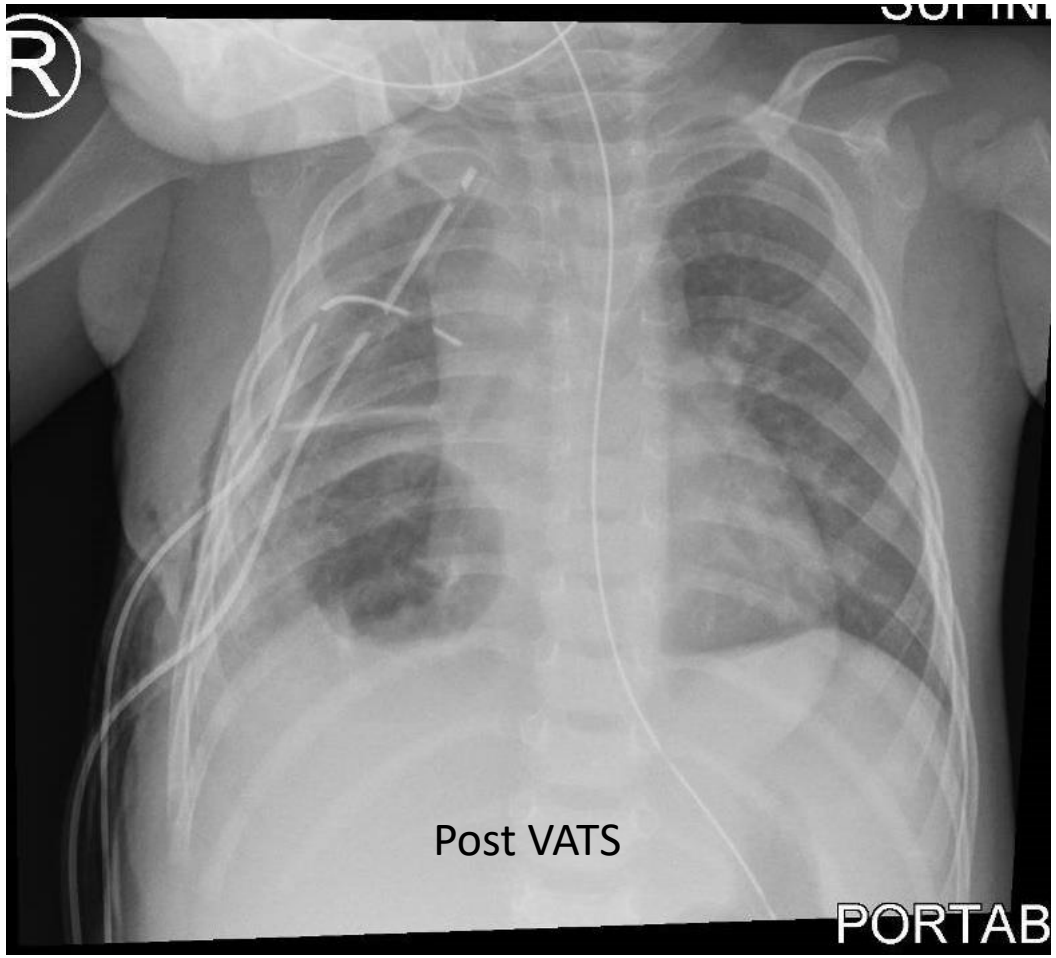
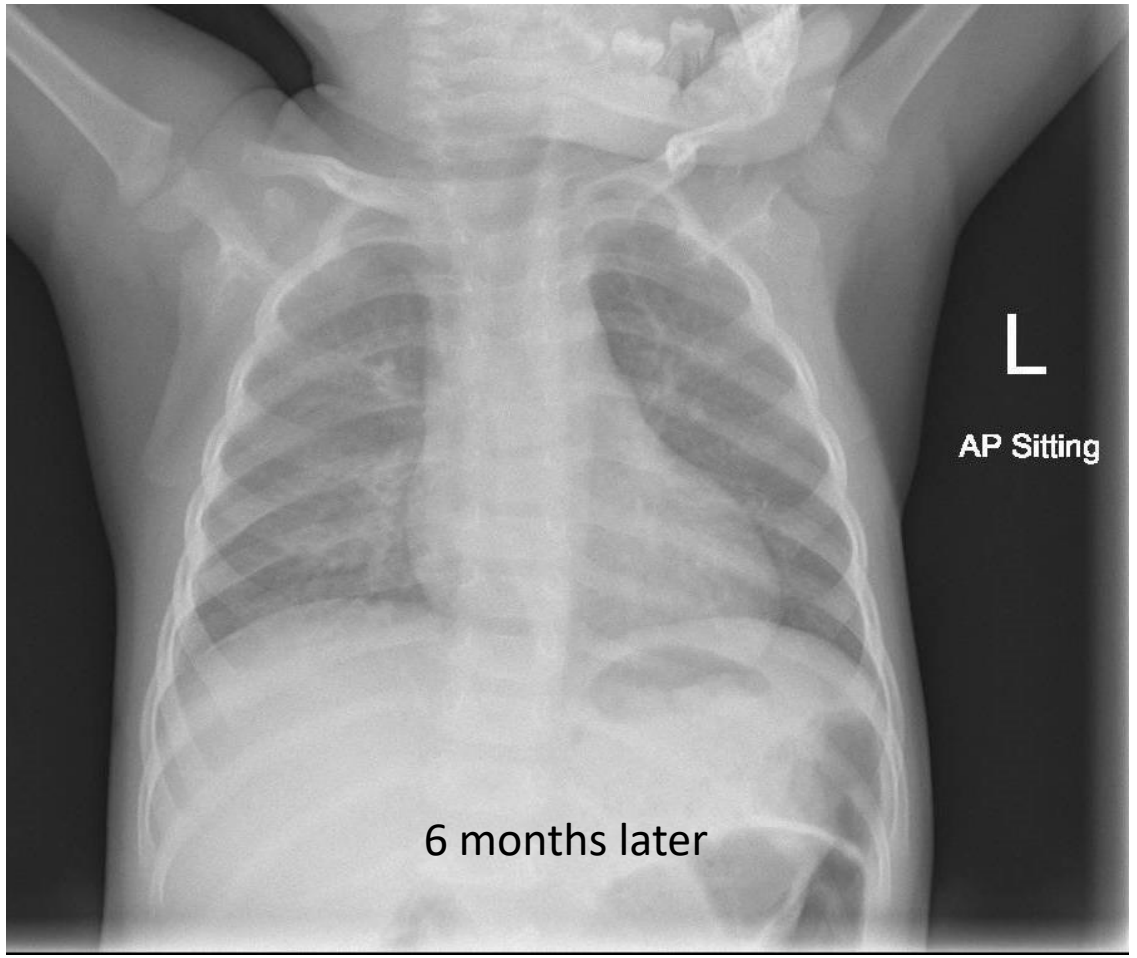
  - Seropurulent fluid within pleural cavity seen and frank pus noted around area of lower lobe cavitating lesion

- Pleural fluid culture
  - S. aureus (scanty growth)
  - Sensitive to cloxacillin, erythromycin, clindamycin, trimethoprim

Case 1



Post VATS



6 months later

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Paediatric Pneumonia – Infective Etiology

Age	Infective aetiology	Oral Antibiotics	Intravenous Antibiotics	
			First-line	No response ≥48–72 hours
Neonate	Group B Streptococcus *E. coli* Listeria Gram-negative bacilli	NA	IV Ampicillin + IV Gentamicin	IV Ampicillin + IV Cefotaxime
1–3 months	Viruses *C. trachomatis* *S aureus* *B. pertussis* *S. pneumoniae*	**Afebrile**	**Febrile**	
		PO Clarithromycin*	IV Ampicillin + IV Cloxacillin	IV Ampicillin + IV Cloxacillin + PO Clarithromycin*

Age	Infective aetiology	Oral Antibiotics	Intravenous Antibiotics	
			First-line	No response ≥48–72 hours
3 months–5 years	Viruses *S. pneumoniae* *H. influenza* *M. catarrhalis* Mycoplasma	**Well looking**	**Toxic looking**	
		If suspect S. pneumonia PO Amoxycillin *If suspect Mycoplasma* PO Clarithromycin	IV Ampicillin 200mg/kg/day *If moderate/ severe RDS or HD/ ICU admission (e.g. requires supplemental O_2 or non-invasive ventilation)* + PO Clarithromycin* *If <1 year and suspect S. aureus* + IV Cloxacillin	**Consider complications of pneumonia** IV Ampicillin 300mg/kg/day + PO Clarithromycin/IV Erythromycin *If <1 year and suspect S. aureus* + IV Cloxacillin
≥5 years	Mycoplasma *S. pneumoniae* *C. pneumoniae*		IV Ampicillin 200mg/kg/day *If moderate/ severe RDS or HD/ ICU admission (eg requires supplemental O_2 or non-invasive ventilation)* + PO Clarithromycin*	**Consider complications of pneumonia** IV Ampicillin 300mg/kg/day + PO Clarithromycin/IV Erythromycin

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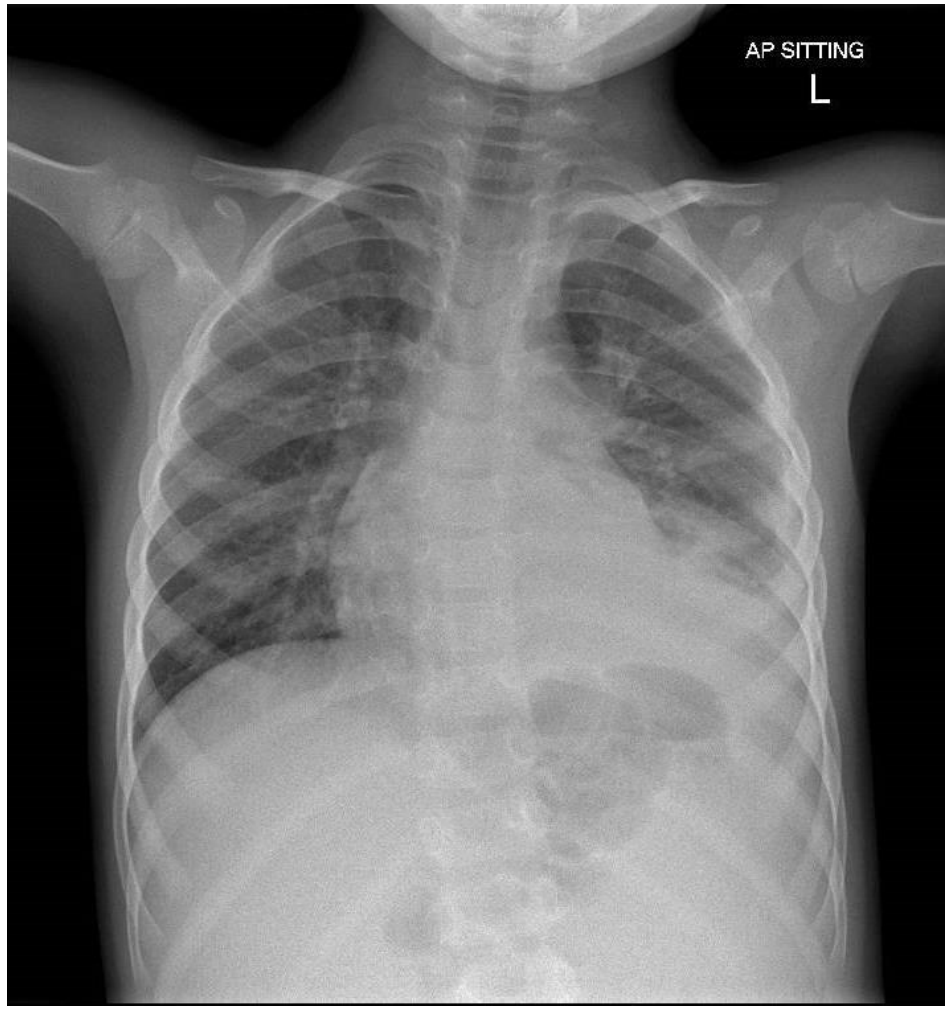
Pneumonia - Staphylococcus aureus

- Typically unilateral in primary staphylococcal pneumonia
- Early CXR may have minimal infiltrates, but may progress rapidly – within hours
- Pleural effusion, pneumatocoeles, pneumothorax common
- Panton-Valentine leukocidin (PVL) toxin producing strain
  - Necrotising pneumonia
  - Community acquired MRSA, MSSA

Case 2

- 5 year old boy
- 2 weeks before admission
  - Fever for a few days
  - Cough, persisting for 2 weeks
- New onset fever 6 days
  - No prior antibiotics
- Admitted after CXR done
- What do you see
- CRP 253 mg/L
- Influenza A positive on NPA, parents declined oseltamivir
- Started on high dose IV ampicillin

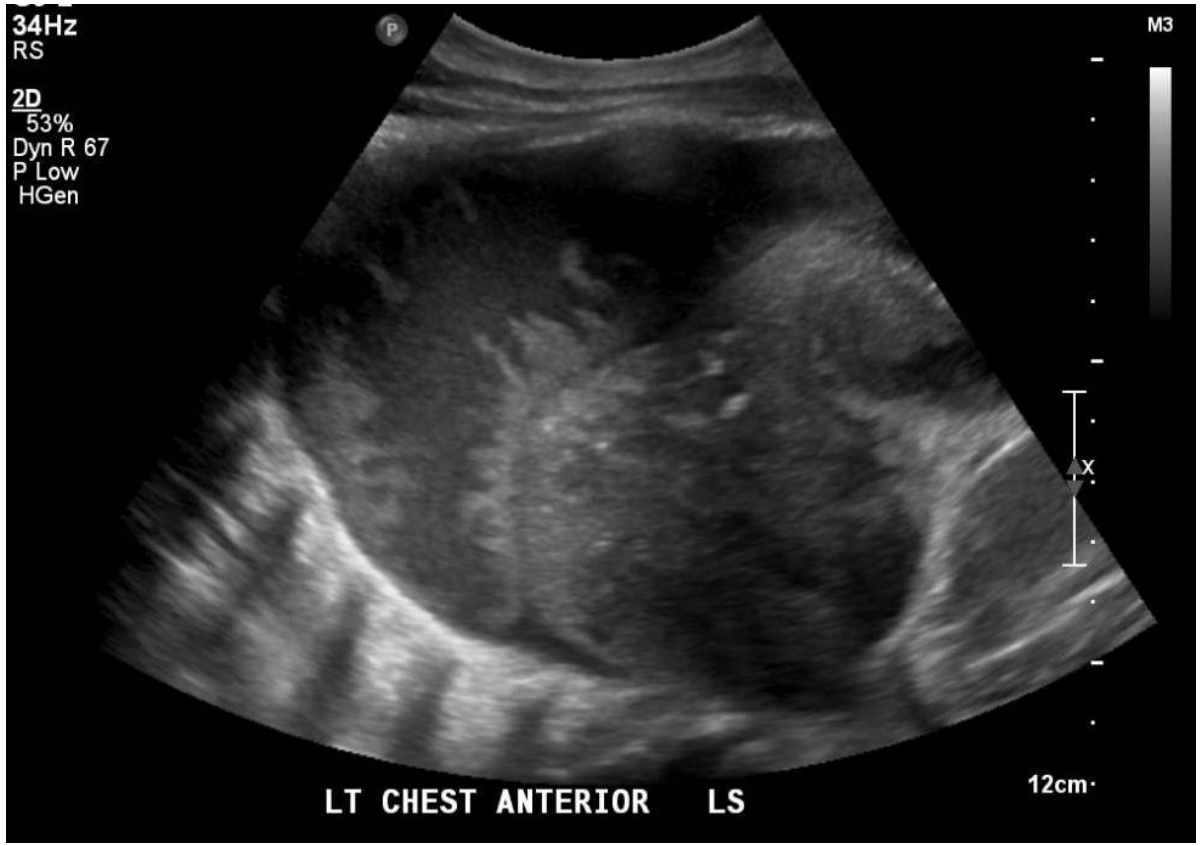


Case 2

- Fever persisted after 72 hours of IV antibiotics
- Reduced air entry on left chest with stony dullness to percussion
- CRP 128 mg/L
- Urine pneumococcal antigen positive
- What would you do?

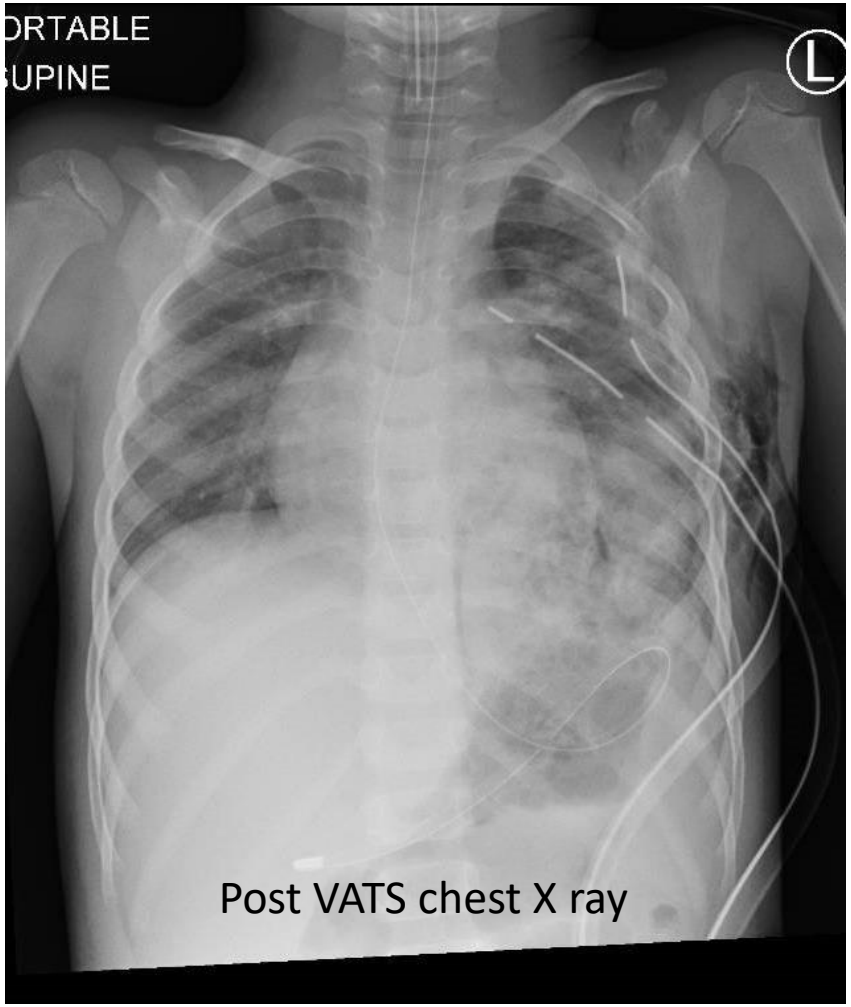
Case 2 – Ultrasound Thorax

- Consolidation in the lower lobe of the left lung
- 2.8 x 1.4 x 1.2 cm cystic space is detected within the lung parenchyma likely impending necrosis/abscess formation
- Pleural effusion with diffuse low level echoes and septations noted with a depth of 4.6 cm
- Pleural surface slightly thickened and irregular
- Left lung empyema
- What would you do?



Case 2

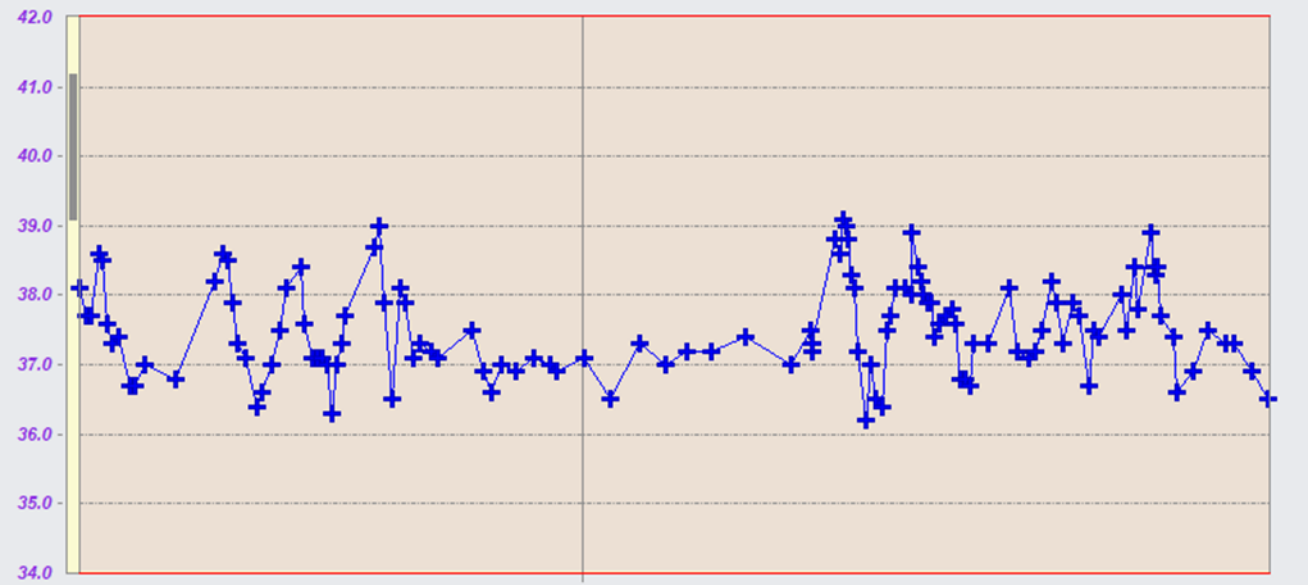
- Referred to paediatric surgeon for VATS
  - Left empyema over both lobes of lung causing collapse of left upper lobe
  - Underlying pneumonia associated with likely abscess in left lower lobe
  - Chest tube 24 Fr posteriorly and 20 Fr anteriorly inserted
  - Noted higher pressure required to re-expand the left upper lobe



Post VATS chest X ray

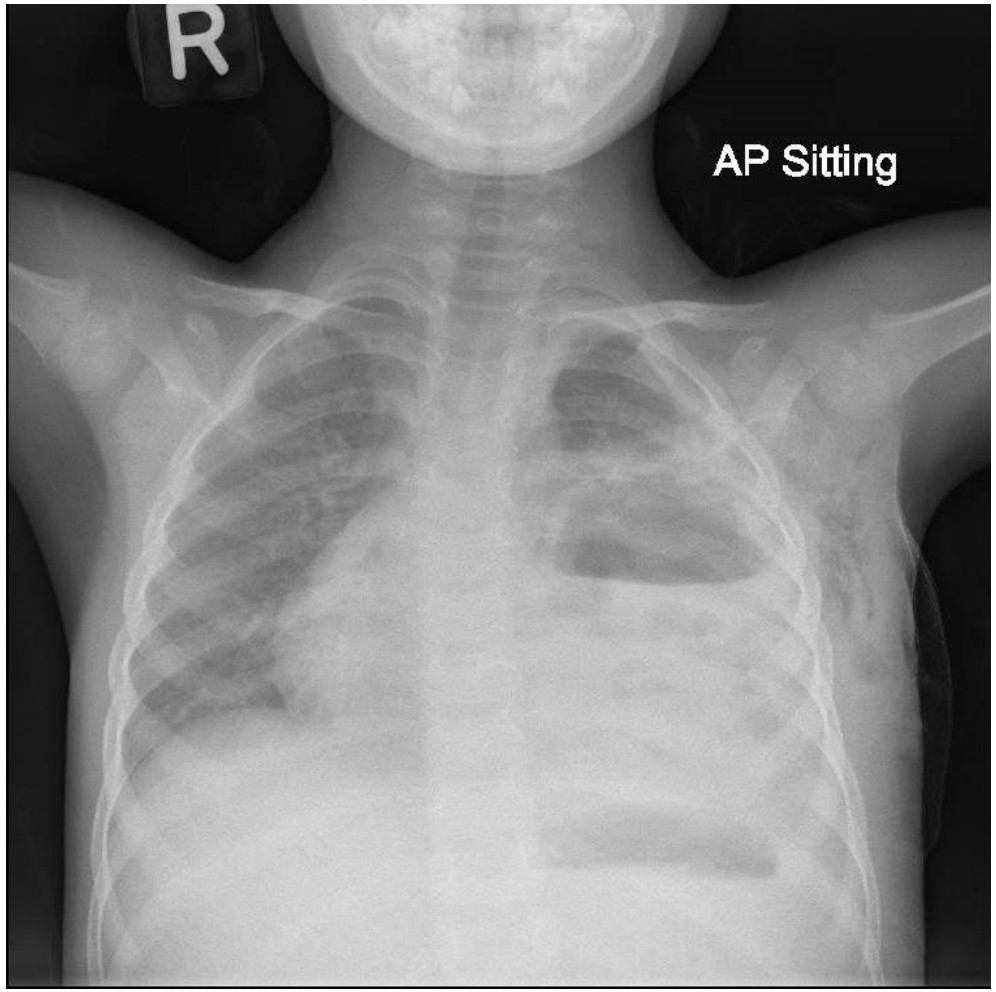
Case 2

- Fever settled post VATS
- Chest drains removed
- Spiked fever within same day 2nd chest drain removed
- CPR 120 mg/L
- Abdominal pain
- What would you do?



Case 2 – Chest X Ray

- What do you see
- What would you do?

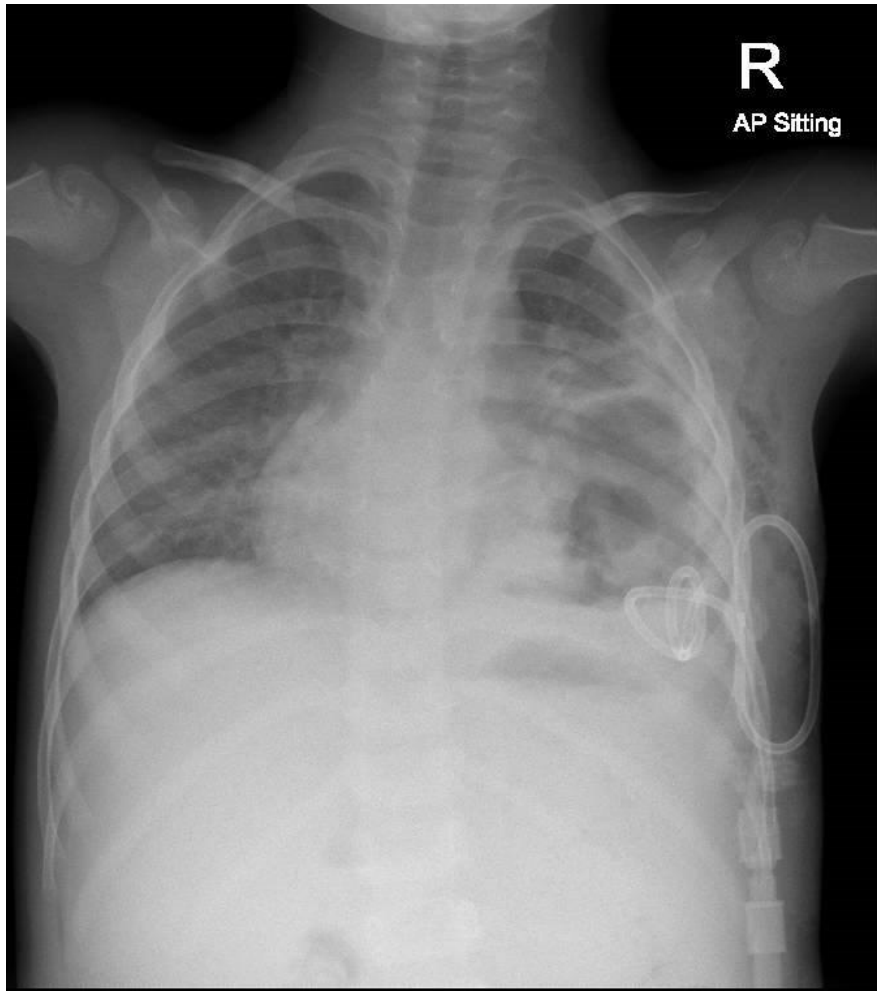


Case 2 – CT Thorax (Sagittal)

- What do you see
  - Loculated pyopneumothorax
  - Necrotizing pneumonia
- What would you do?

Case 2

- Interventional radiologist inserted cope loop catheter
- CRP 100 mg/L
- Pleural fluid latex agglutination – Strep. pneumoniae
- Fever settling



Complications of Pneumonia in Children

- Complicated pneumonia in 39% of hospitalized pneumococcal pneumonia
  - Pleural effusion (83%)
  - Empyema (52%)
  - Necrotising pneumonia
  - Lung abscess
  - Pneumatocoele (19%)
  - Pneumothorax (10%)
  - Atelectasis (26%)

- Complications correlate with
  - Weight ≤ 10th percentile for age
  - Respiratory distress
  - Anaemia
  - White cell count ≤ 15,000/uL

Clinical characteristics and outcome of complicated pneumococcal pneumonia in a pediatric population. Wexler et al, Pediatr Pulmonol 2006

Parapneumonic Effusion & Empyema

- Pleural effusion associated with pneumonia, secondary to
  - Spread of inflammation
  - Leakage of protein, fluid and leukocytes

- Empyema
  - Bacteria invasion
  - Presence of grossly purulent fluid in the pleural cavity

- Development of pleural empyema determined by a balance between
  - Host resistance
  - Bacterial virulence
  - Timing of presentation for medical treatment

Epidemiology

- Risk factors
  - Immunodeficiencies
  - Influenza
  - Cerebral palsy
  - Down syndrome
  - Cystic fibrosis
  - Tuberculosis
  - Congenital heart disease
  - Malignancy
  - Prematurity
  - Congenital thrombocytopenia
  - Post surgical
  - History of oesophageal stricture

Organisms

- Streptococcus pneumoniae
  - Penicillin-susceptible strains
  - Penicillin and cephalosporin resistant strains
- Staphylococcus aureus
  - Developing world
  - Community-associated methicillin-resistant strains
- Haemophilus influenzae
- Mycoplasma pneumoniae
- Others
  - Coagulase-negative staphylococcus aureus
  - Viridans streptococcus
  - Group A streptococcus
  - Alpha-haemolytic streptococcus
  - Anaerobic bacteria e.g. Bacteriodes, Fusobacterium (neurologically impaired children)
  - Actinomyces species
  - Fungi e.g. Candida (nosocomial)
  - Viruses e.g. Adenovirus, Influenza, Respiratory Syncytial Virus

Symptoms

- Persistent fever
- Cough
- Dyspnoea
- Chest pain
- Abdominal pain (referred)
- Malaise
- Decreased appetite
- Lie on affected side

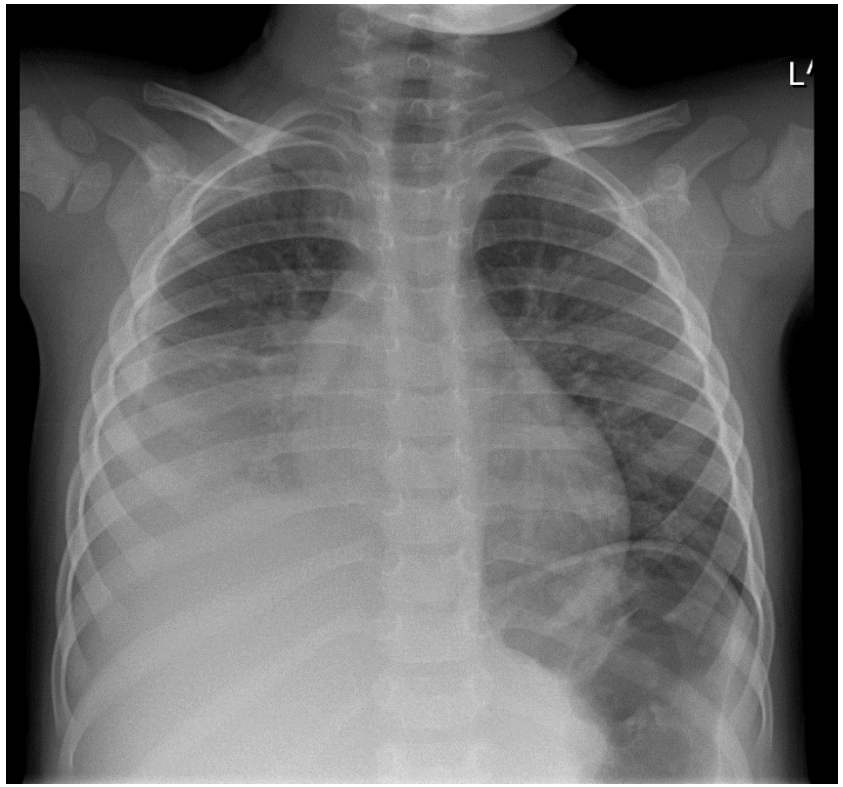
Signs

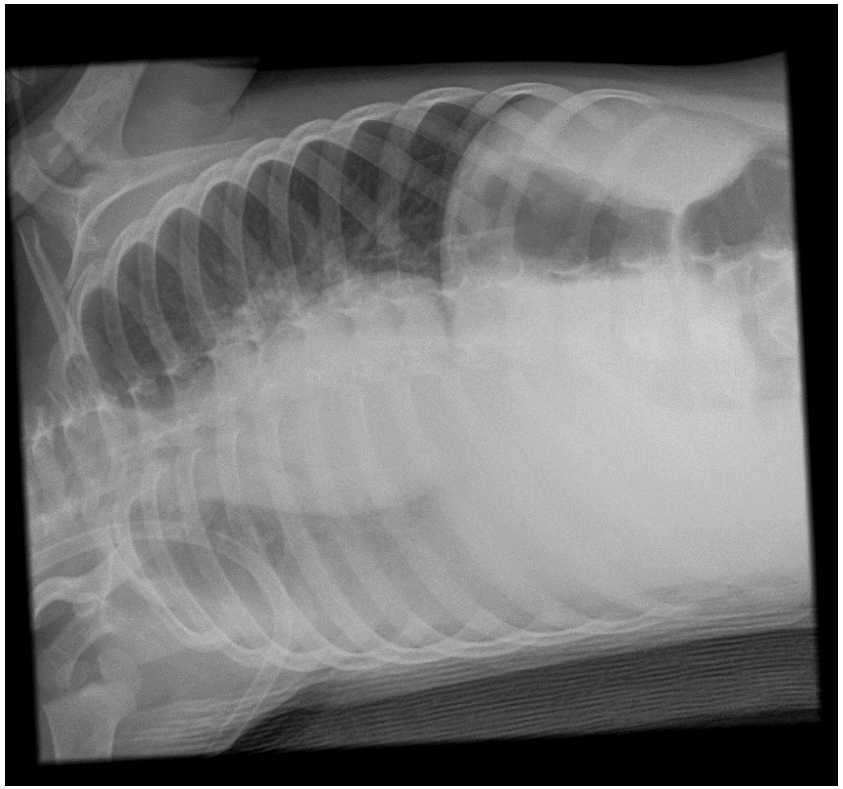
- May be ill or toxic looking
- Tachypnoeic
- Shallow respiration
- Respiratory distress
- “New” mild scoliosis, splinting towards affected side
- Dullness to percussion, decreased air entry on affected side
- Pleural rub
- Mediastinal shift
- Hypotension

Investigations

- CXR
  - AP or PA
    - Costophrenic angle obliteration
    - Meniscus sign, layered fluid
    - Whiteout lung field
    - Scoliosis
    - May differentiate between free and loculated fluid, but not between parapneumonic effusion and empyema
    - Other etiology – widened mediastinum, hilar lympadenopathy, cardiomegaly, bony lesions
  - Decubitus
    - Free fluid layers out on dependent chest wall
    - Decubitus layer > 1cm in older children considered sufficient volume for thoracentesis

Free Pleural Effusion

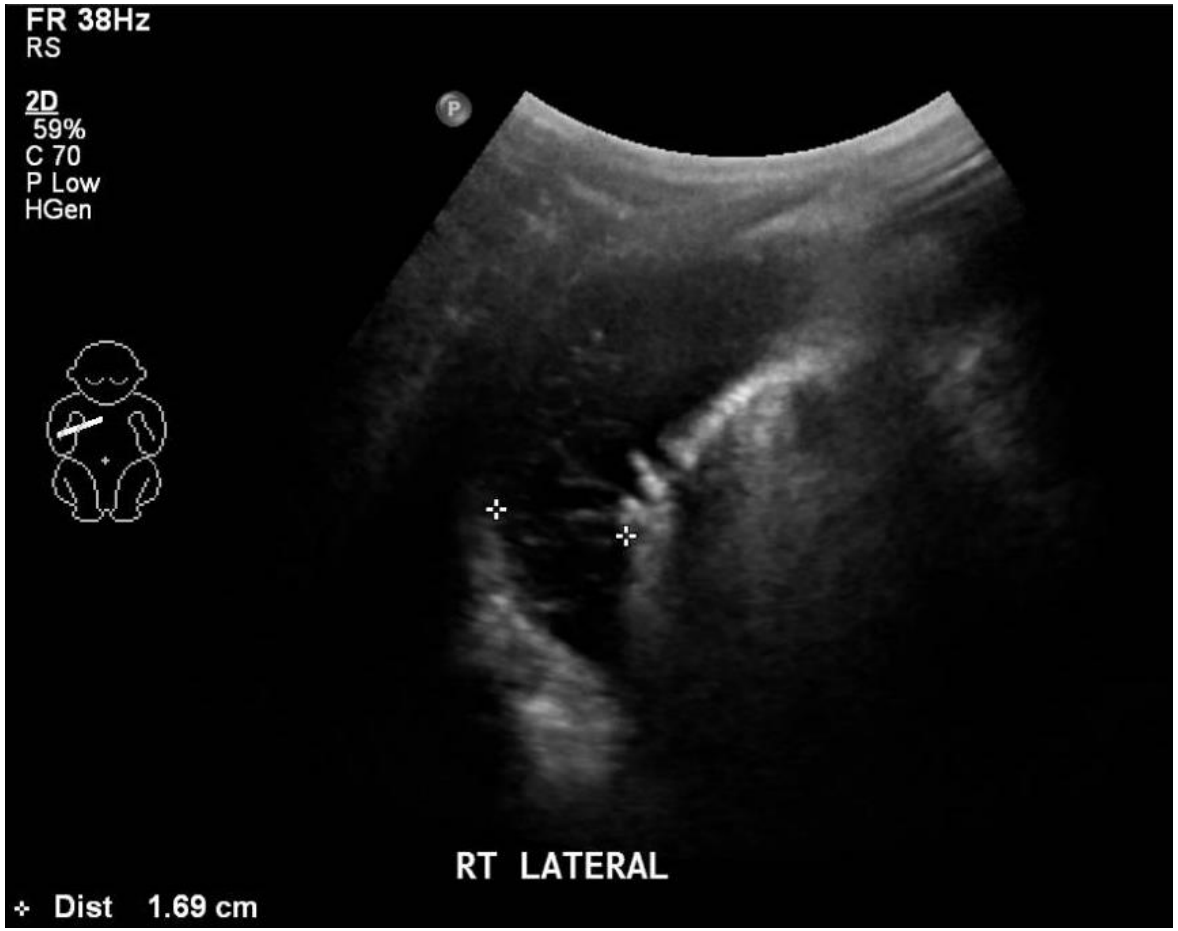




Investigations

- Ultrasound thorax
  - Confirms presence of fluid in thorax, especially in whiteout lung fields
  - Quantification of effusion
  - Detection of septations, loculations, pleural thickening and echogenic patterns
  - Localisation of optimal site for thoracentesis or chest drain insertion
  - Does not require sedation
  - No radiation
  - Operator dependent

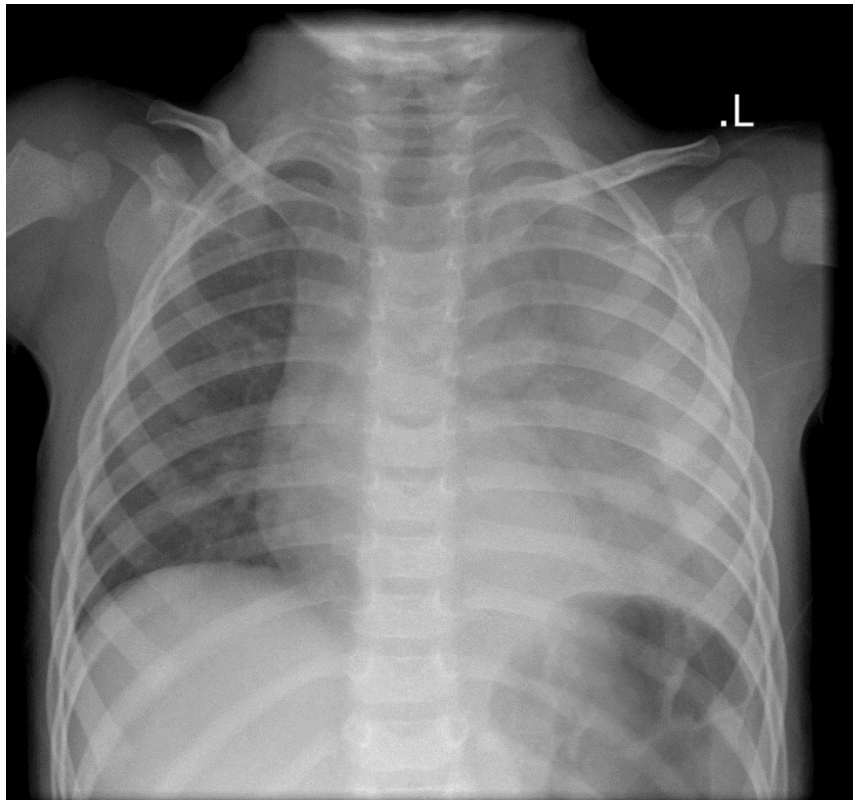
Effusion with Septation

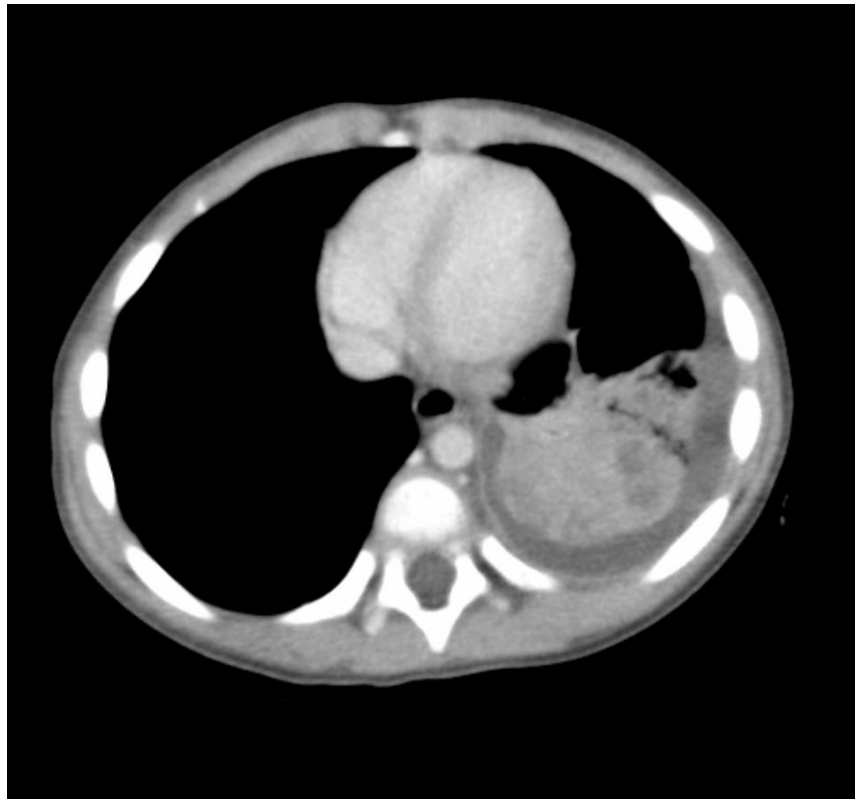


Investigations

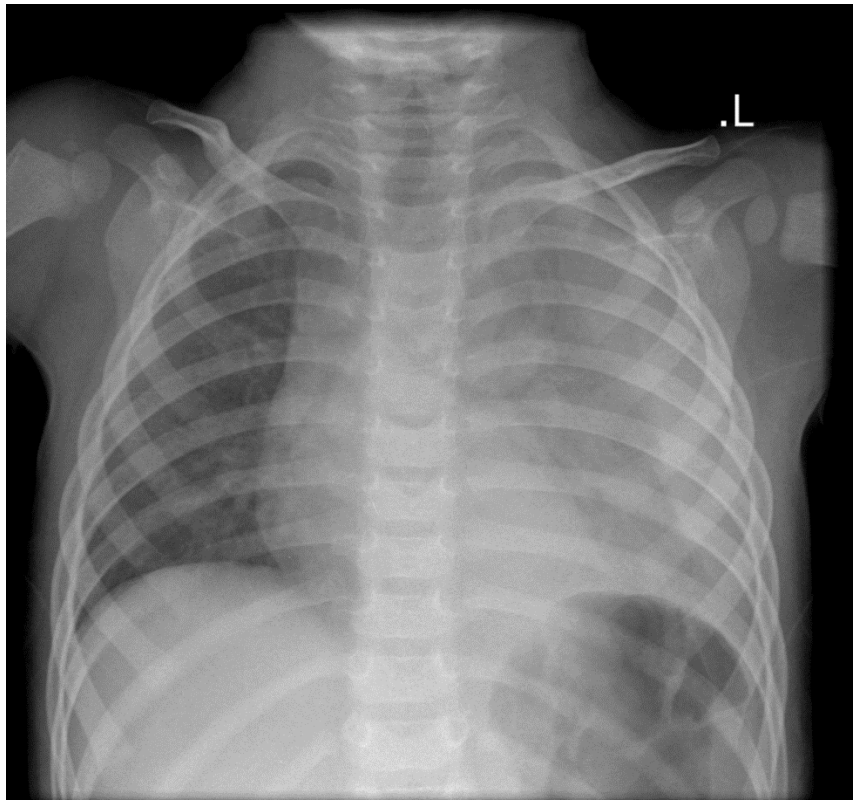
- CT thorax
  - Determine presence of pleural fluid
  - Detects pleural peel, “scalloping”
  - Detects lung parenchyma changes – necrosis, abscess
  - Should not be routine
    - Complicated cases failing medical management
    - Failure to aspirate pleural fluid
    - Suspected malignancy
    - Immunocompromised children
    - Roadmap for surgeons before surgery
  - Radiation

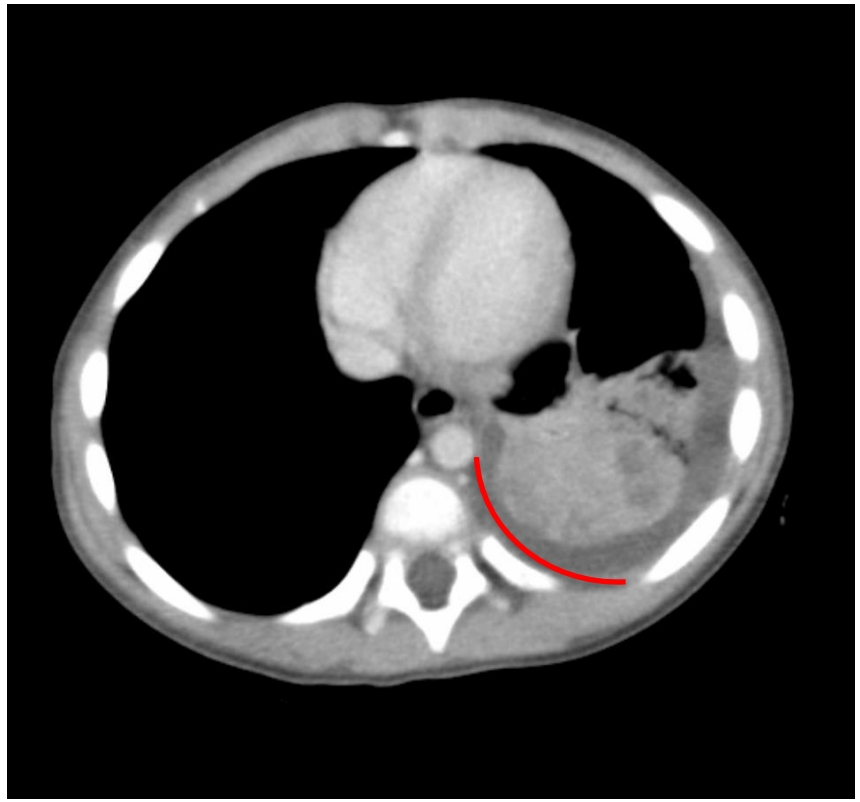
Empyema



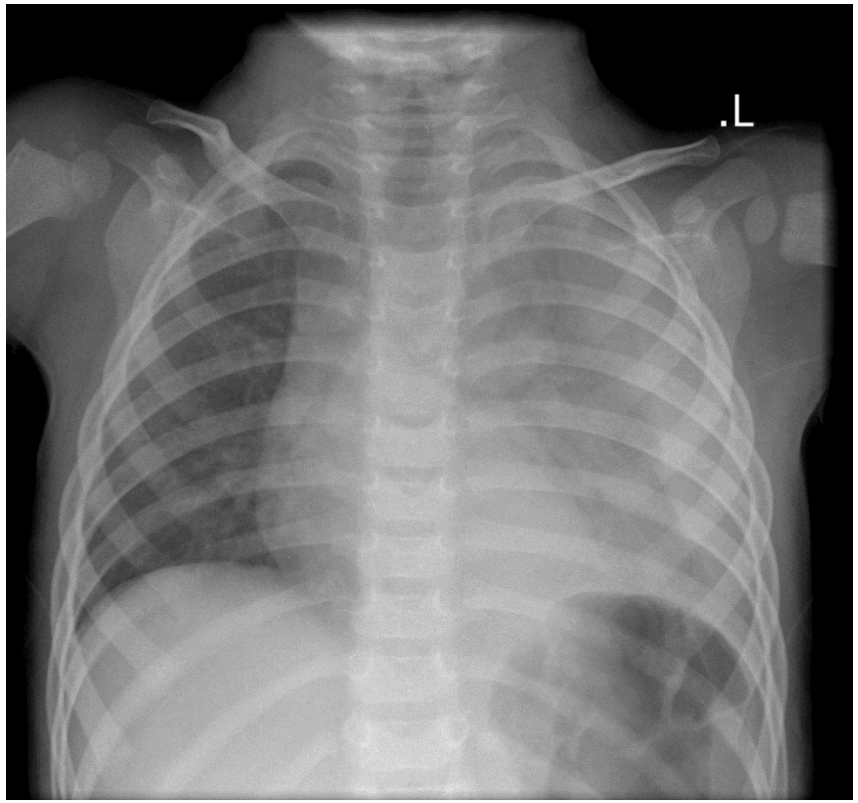


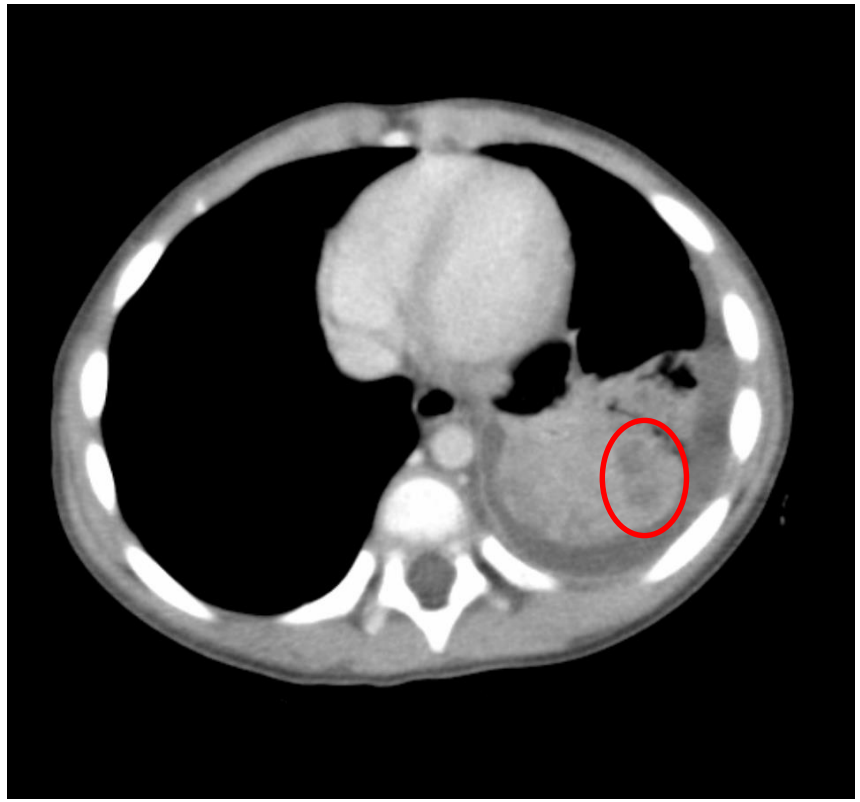
Empyema





Empyema





Management

- Goals of therapy
  - Sterilization of the pleural cavity
  - Drainage of the pleural fluid
  - Re-expansion of the lung

Management

- No global consensus on medical versus surgical management
  - Data cannot be extrapolated from adult studies, with increased morbidity and mortality due to underlying lung diseases
  - Limited evidence from randomised controlled trials in children
  - Retrospective series biased by local practice and may be influenced by changes in prevalent organisms and advances in imaging and surgical techniques
  - Availability of resources
  - Expertise of physician/surgeons

Management

- Basic and supportive therapy
  - Antibiotics
  - Supplemental oxygen
  - Intravenous rehydration
  - Antipyretics
  - Analgesics
  - Early mobilisation
  - Ventilatory and inotropic support if required
  - No role for routine
    - Chest physiotherapy
    - Bronchodilator therapy

Management

- Specific management
  - "Medical"
    - No chest drain
    - Chest drain alone (chest tube or ultrasound guided pigtail catheter)
    - Chest drain with intrapleural fibrinolytic agent
  - Surgical
    - Video-assisted thoracoscopy (VATS)
    - Thoracotomy/mini-thoracotomy
  - Numerous management algorithms (e.g. BTS, APSA)
  - Choice of management depends on
    - Stage of disease at presentation
    - Clinical status of the child
    - Local practice, resources and expertise available

Stage of Disease - Size

- Small parapneumonic effusion
  - Fluid occupying < 1cm on lateral decubitus radiograph
  - Opacifying less than ¼ of the hemithorax

- Moderate/large parapneumonic effusion
  - Fluid occupying > 1 cm on lateral decubitus radiograph
  - Opacifying more than ¼ of the hemithorax

Stage of Disease - Complexity

- Simple parapneumonic effusion
  - Early in disease course
  - Sterile
  - Free flowing
- Loculated parapneumonic effusion
  - Septations present
  - Interferes with free flow of fluid
- Empyema
  - Presence of bacterial organisms in pleural fluid
    - Grossly purulent

Complicated parapneumonic effusion

Small (Simple) Parapneumonic Effusion

- Oral or IV antibiotics
- Repeat chest X ray
  - If no clinical improvement in 24 to 48 hours
  - Worsening fever, clinical symptoms/signs

Moderate/Large Simple Effusion

- IV antibiotics with chest drain
  - Respiratory compromise
  - Very large effusion – occupying more than ½ of the hemithorax
  - Proceed to therapy for loculated fluid or empyema if no clinical response after 24 to 48 hours
- Trial of antibiotics without chest drain
  - Clinically stable
  - Moderate effusion
  - Proceed to chest tube or surgical drainage if no clinical response after 24 to 72 hours

Loculated Effusion or Empyema

- IV antibiotics, chest drain with intrapleural fibrinolytic therapy
  - 6 doses of intrapleural urokinase twice daily for 3 days
  - 40,000U in 40mls normal saline (10,000U in 10mls normal saline if child <10kg), leave to dwell in the pleural cavity after instillation for 4 hours before unclamping the chest tube
- Video-assisted thoracoscopic surgery (VATS)
- Both are accepted 1st line therapy

Considerations in Management

Treatment	Notes	Advantages	Disadvantages
Intrapleural fibrinolytics Urokinase in KKH, though chest tube or US guided pigtail catheter	Acceptable 1st line therapy Lyses fibrin strands and clears lymphatic pores Overcomes chest tube occlusion Comparisons between studies difficult: • Different protocols and fibrinolytics • Unknown optimal dose • No RCTs comparing different agents (streptokinase, urokinase, alteplase)	In RCTs compared to VATS: • No difference in hospital LOS after intervention • Success rate 80–90% • Lower cost	Failure rate 10–20% Adverse effects: • Fever • Pain • Intrapleural bleeding • Anaphylaxis (rare) **Contraindication:** • Bronchopleural fistula • Ongoing air leak/bubbling chest tube • Bleeding diathesis • Significant haemorrhage

Considerations in Management

Treatment	Notes	Advantages	Disadvantages
Surgery – VATS	Acceptable 1st line therapy Debridement, breakdown of loculations and drainage of pus under direct vision through 2–3 small incisions	In retrospective reviews compared to intrapleural fibrinolytics: • Lower failure rate (2.8% vs 9.4% – range 6.7% to 14.2%) • Lower complication rate (5.4% vs 12.5% – range 0% to 16.6%) Early VATS enhance the chance of full expansion of collapsed lung	One lung ventilation intraoperatively, dependent on surgical experience and expertise No difference in clinical outcomes compared with fibrinolytics in RCTs, but more expensive

Management – Other Considerations

- Location of the pleural effusion/empyema
- Duration of illness
- Prior treatment
  - Antibiotics - ? Duration ? Dose ? Appropriate
  - Chest drain - ? Draining well ? Reason for not draining
- Any other cause of the fever or clinical deterioration
  - Necrotising pneumonia, lung abscess
  - Concomitant infection
  - Atypical organism
  - Other causes
- Country of residence - ? Local antibiogram ? Local epidemiology
- Parental preference - ? Procedure/surgery averse ? Cost

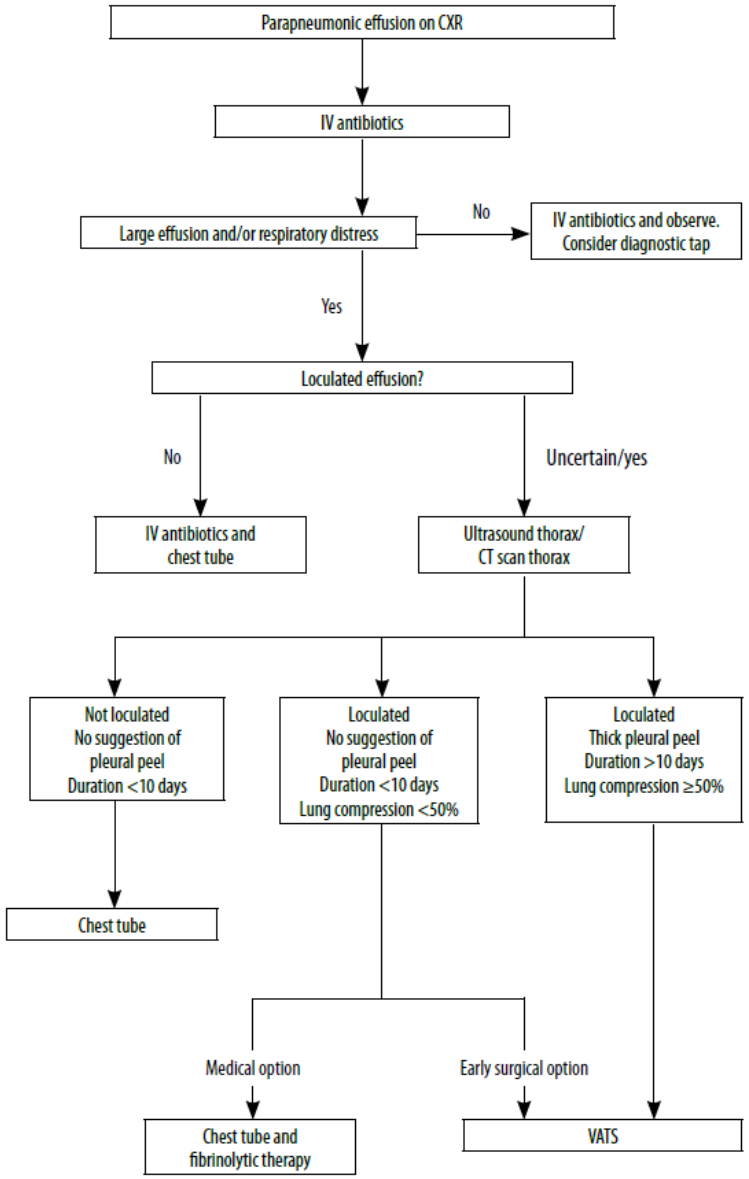


Figure 14.1: Algorithm for the management of parapneumonic effusion and empyema

KKH Baby Bear Book

Lung Abscess

- Thick walled cavities (≥ 2 cm) containing purulent material due to acute destruction of lung parenchyma following inflammation, necrosis and cavitation
- IV antibiotics for 2 to 3 weeks then oral for 4 to 8 weeks
- Surgical intervention
  - Prolonged medical therapy unsuccessful
  - Suspected neoplasm, congenital lung malformation
  - Respiratory compromise e.g. mediastinal shift, uncontrolled haemoptysis, respiratory failure
  - Ongoing sepsis syndrome
  - Signs of progressive infection e.g. enlarging cavity, infection of other lung lobes
- Surgical options
  - Percutaneous drainage
  - Endoscopic drainage
  - Lobectomy
  - Pneumonectomy

Complications of Pneumonia in Children

- Sepsis
  - Septic shock
    - Tachycardia
    - Hypotension
  - Disseminated intravascular coagulation (DIC)
    - Consumptive coagulopathy
    - Haemorrhage
    - Microvascular thrombosis
    - Microangiopathic haemolytic anaemia
- Inappropriate secretion of antidiuretic hormone (SIADH)
  - Hyponatraemia

Complications of Pneumonia in Children

- Haemolytic uraemic syndrome
  - Pneumococcal-associated HUS reported in 5% to 15% of all childhood HUS cases
  - Mainly in infants and young children
  - Incidence of HUS after pneumococcal disease is 0.5%
    - 70% from pneumococcal pneumonia
    - 20% to 30% from pneumococcal meningitis
    - Other sites – isolated bacteraemia, sinusitis, otitis media

Complications of Pneumonia in Children

- Compared to Shiga toxin-producing E. coli HUS, children with pneumococcal associated HUS
  - Are younger - median age between 1 to 2 years old
  - Have more severe initial disease with longer duration of oliguria and thrombocytopenia
  - Require more transfusions
  - Up to 70% to 80% require dialysis therapy
  - Extra-renal complications common – pancreatitis, purpura fulminans, cholecystitis, thrombosis, cardiac dysfunction and hearing loss

IT IS NOT WHICH IS BETTER
BUT
WHICH IS THE BEST FOR MY PATIENT

THANK YOU