Investigations for Pneumonia

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Peripneumonia, and pleuritic affections, are to be thus observed: If the fever be acute, and if there be pains on either side, or in both, and if expiration be if cough be present, and the sputa expectorated be of a blond or livid color, or likewise thin, frothy, and florid, or having any other character different from the common... When pneumonia is at its height, the case is beyond remedy if he is not purged, and it is bad if he has dyspnoea, and urine that is thin and acrid, and if sweats come out about the neck and head, for such sweats are bad, as proceeding from the suffocation, rales, and the violence of the disease which is obtaining the upper hand. – Hippocrates [460 BC – 370 BC] (Fig. 1).

The above description of pneumonia by Hippocrates [460 BC – 370 BC] is a very clear and crisp account of the evolution of pneumonias. One also needs to understand that the above statement was made in the pre-antibiotic era – today's scenario being completely different where both the clinical and radiological presentation and the subsequent relevant investigations become vital to the proper diagnoses and therapy of pneumonias. One also needs to take into account the looming giant of drug resistant bacteria.

The decision making process in a pneumonia needs to answer the following questions in logical sequence to try and initiate a concise investigative approach to the patient with pneumonia.

Fig. 1 : Pneumonia strikes

Table 1 : Clinical Pointers to Infection

Feature	Pointer to infection
Cough	Purulent sputum
Temperature	Pyrexia Rigor
Sweats	Drenching and at night suggest TB
Chest signs	Features of consolidation
White cell count	Raised
C-reative	Raised
Chest radiograph	Focal shadowing

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A good history and clinical examination will invariably enable us to pin down the diagnosis of pneumonia. A patient with pneumonia will present with abrupt onset fever, cough and expectoration which may be blood tinged along with persistent spiking fever. The presence of typical pleuritic chest pain, purulent sputum and raised peripheral blood count will clinch the diagnoses of a pneumonia. Markers like CRP and pro calcitonin are probably pointers towards an infection but are not cost effective investigations today (Table 1). Certain specific pathogens are associated with specific types of pneumonias as below (Table 2):

The severity and intensity of the pneumonia will obviously depend upon the infective organism. This is will be dictated by various factors like the background presentation – comorbid illness- prior hospitalization and consumption of antibiotics.

The identity of organism will ultimately dictate the course of the disease and the treatment and outcomes there of. The common organisms causing CAP are depicted below and the commonest infective organism appears to be streptococcus pneumonia (Fig. 2).

There are a number of clinical severity scores which are well validated and very useful in clinical practice. The most practically applicable of the scores would be the CURB 65 score which is consistently reproducible and well validated. It is got few specific parameters and is easy to implement on a daily basis. The other score is the PORT Score which is more complicated and contains more parameters and may be more difficult to use on a day to day basis (Table 3).

Table 2 : Classification of the Pneumonias According to likely Origin and Immune Status

Pneumonia Group	Likely Pathogens
Community acquired	Gram – positive bacteria Mycoplasma, Chlamydia, Coxiella Common viruses (eg. Influenza)
Nosocomial, early	As for community acquired
Nosocomial, late	Gram –ve enterobacteria Staphylococcus aereus Antibiotic resistant bacteria
Immunocompromised	Opportunistic organisms

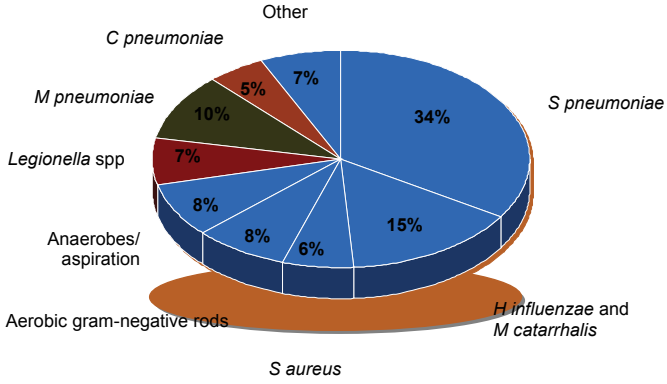


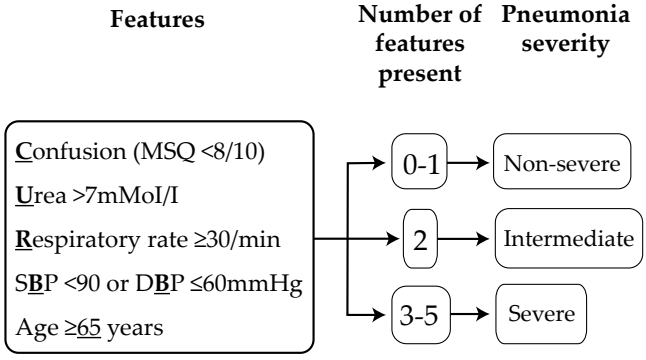
Fig. 2 : Key Pathogens Associated with Community-Acquired Pneumonia (CAP)

Table 3 : PORT risk class

Risk class	Criteria	%Mortality	
		Outpatient	Inpatient
I	Age < 50 years No existing illnesses or viral sign abnormalities	0	0.5
II	70 points	0.4	0.9
III	71-90 points	0	1.25
IV	91-130 points	12.5	9.0
V	131 points	NA	27.1
Mean		0.6	8.0

The port score takes multiple parameters like age, comorbid conditions, laboratory and radiologic parameters in arriving at a final risk class as above

CURB 65 Sore



The severity scores will help us differentiate simple from complicated pneumonias and will serve as a useful index of differentiating patients who can be treated at home and those who need to be treated in hospital. In general the majority of patients with CAP can be treated at home and hence this differentiation assumes great importance with relevance to the utilization of hospital beds and resources.

Needless to say the identification of the bacteria is probably the most crucial investigation that will impact on the morbidity and mortality of the disease process. The hunt for the bacteria can be divided into two classes namely routine investigations and specialised investigations which are reserved for patients who need to be treated in hospital.

Identification of Bacteria

Routine Investigations

1. **Gram Stain :** The granstain is probably one of the most talked about but least performed investigation in pneumonia. It can be performed quickly on expectorated specimen to predict the possible etiology of the infective organism. This can result in more effective empiric antibiotic therapy which is crucial in a country like India where an etiologic agent is not identifiable in more than half the number of patients. It is important to stress on the quality of expectorated specimen which needs to be from the deep lung and free from salivary contamination. The expertise of the micro biologist and recent antibiotic therapy will also play a key role in the final outcome of a gram stain examination. Needless to say that a ZN stain to look repeatedly for acid fast bacilli will be vital in ruling out TB which can mimic many of the pneumonias in presentation.
2. **Sputum Culture:** This is a sensitive means of identifying the bacteria. The gross appearance of sputum may provide a clue to the quality of the expectorate - a grossly purulent sputum is likely to yield better results then a sputum which is contamination with saliva. A corelation between the granstain and culture will augment the final validity of the organism in question. The ability to perform **quantitative cultures** will definitely improve the quality and will also be a prognostic indicator of treatment response. Tissue culture techniques will be required to isolate viruses and atypical organisms.
3. **Blood Culture :** Blood cultures are an absolute necessity in patients who are sick enough to be in hospital. It may be not be necessary in out patients but this need to be modified according to the clinical picture. Antibiotic therapy prior to presentation may have a profound effect on the final outcome of the blood culture.
4. **Serology :** These are measurements of specific antibody response to micro organisms and have limited application in day to day practice. The atypical organisms may be more sensitive to serological measurements but as a whole serology has an extremely limited role in the diagnosis of community acquired pneumonia.
5. **Nucleic Acid Detuction :** Nucleic acid amplification techniques such as PCR – polymerase chain reaction are being increasingly used to detect bacteria and they will be more useful for the detection of organisms like M Tuberculosis, C pneumonia, L pneumophila and opportunistic pathogens. These tests are extremely sensitive and cannot differentiate between latent infection and active disease.

Specialized Investigations

1. **Fiberoptic Bronchoscopy :** Bronchoscopy appears to be an attractive method for collecting specimen but it also beset by the problem of oropharyngeal contamination. This may be reduced by the use of PSB – protected specimen brush and bronchoalveolar lavage. Quantitative culture will greatly increase the diagnostic potential. BAL will cover a larger area of the lung than PSB.
2. **Transthoracic Needle Aspiration –TTNA :** This procedure involves use of a fine needle inserted through a larger needle that penetrates the skin and the chest wall. Then 2 to 4 ml of normal saline is injected and immediately aspirated. It is more often used in pediatric and immunocompromised patients. Major complications would be the development of pneumothorax and bleeding.
3. **Transtracheal Needle Aspiration :** TTA was a very popular means to obtain specimens through the cricothyroid membrane and the subsequent insertion of a catheter for aspiration. Major complication include bleeding and paroxysmal cough.

Radiology

A chest radiograph is an absolute necessity in patients with suspected pneumonias not only for confirming diagnosis but also to rule out other abnormalities. The infections can be confined to the airways or to the lung parenchyma. Three distinct radiological patterns are identifiable. Lobar or non segmental pneumonia – bronchopneumonia or lobular pneumonia and intestitial pneumonia. The radiological presentation can sometimes give us a clue to the infecting organisms (Table 4).

Table 4 : Radiological Pattern and Etiological Agent

Pneumonia	CXR shadows	Occasional additional features	Likely organisms
Lobar	Homogeneous - most of a lobe Or	Air bronchogram	Streptococcus pneumoniae
	Non segmental – i.e. patchy but confined to a lobe	Swelling or expansion of the affected lobe May cavititate	Klebsiella pneumoniae
Broncho pneumonia	Nodular and linear opacities are scattered and diffuse When severe – the nodules enlarge and coalesce	Mucus plugging - inflammatory narrowing can cause volume loss Pleural effusion	Numerous, including : Klebsiella pneumoniae Escherischia coli Psudomonas Staphylococcus aureus Straptococcus pneumoniae (pneumococcus) Anaerobes

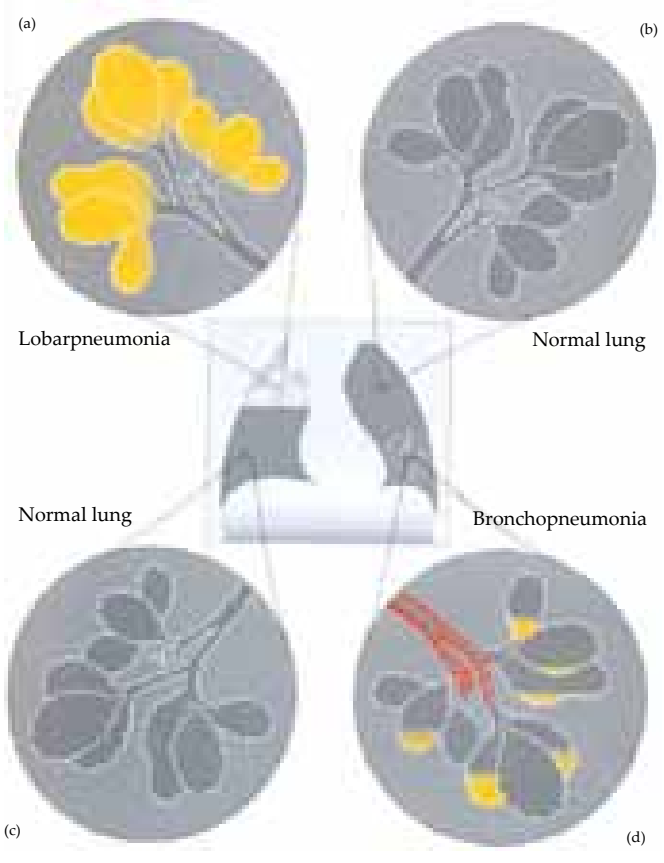


Fig. 3 : Evolution of pneumonias – Lobar Pneumonia – exudation starts distally and spreads contiguoulsy, Broncho Pneumonia - infections spread along the airway and finally reaches the distill areas

There are however limitations to this radiological approach and sometimes it may be not possible to identify organisms based on the radiological pattern alone. This may be due to many factors including age, immunological status and the pathology of the underline lung.

1. **Lobar Pneumonia :** In a lobar pneumonia bacterial exudation starts distally and spreads through the terminal air spaces resulting in flooding of the alveoli (Fig. 3). Air Bronchograms are a classical feature of lobar pneumonia (Fig. 4).

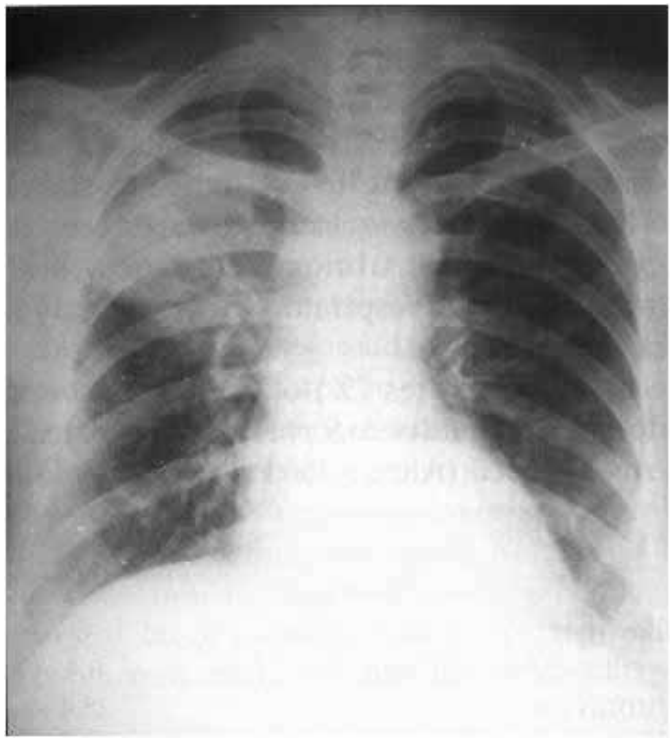


Fig. 4 : Lobar pneumonia showing dense consolidation mostly confined to one lobe, cavitation is rare- air bronchogram is seen in this right upper lobe consolidation

2. **Broncho Pneumonia :** The infections spread along the airway and finally reaches the distill areas. The radiologic pattern is poorly defined and is often patchy and may be confluent over a period of time.
3. **Interstitial :** The predominant damage is to the bronchiolar walls and the interstitium. Linear, reticular and small nodular opacities are seen. The classic examples are viruses and mycoplasma. Viral pneumonia can mimic a lobar pneumonia.

Fig. 5 shows classical staphylococcal pneumonia with diffused infiltrates and pneumatocele formation and Fig. 6 shows klebsiella pneumonia - bulging fissures and cavitations due to intense exudation are characteristic.

A very clear distinction between lobar and broncho pneumonia may some times be difficult to elucidate. The site of the pneumonia with relevance to the cardiac and mediastinal borders can be identified by the SILHOUETTE SIGN – an intra thoracic lesion touching the heart border or diaphragm will obliterate that border on the chest x-ray. A lesion not anatomically contiguous will not obliterate that border. This sign is generally attributed to Benjimin Felson a ground breaking twentieth century American radiologist.

In summary the clinical picture at the time of presentation appears to be the chief predictor of morbidity and mortality and when this is complemented by simple and relevant investigations, the diagnosis and treatment of pneumonias will become easy and uncomplicated (Fig. 7).

One has to only go back in time and look at the classic

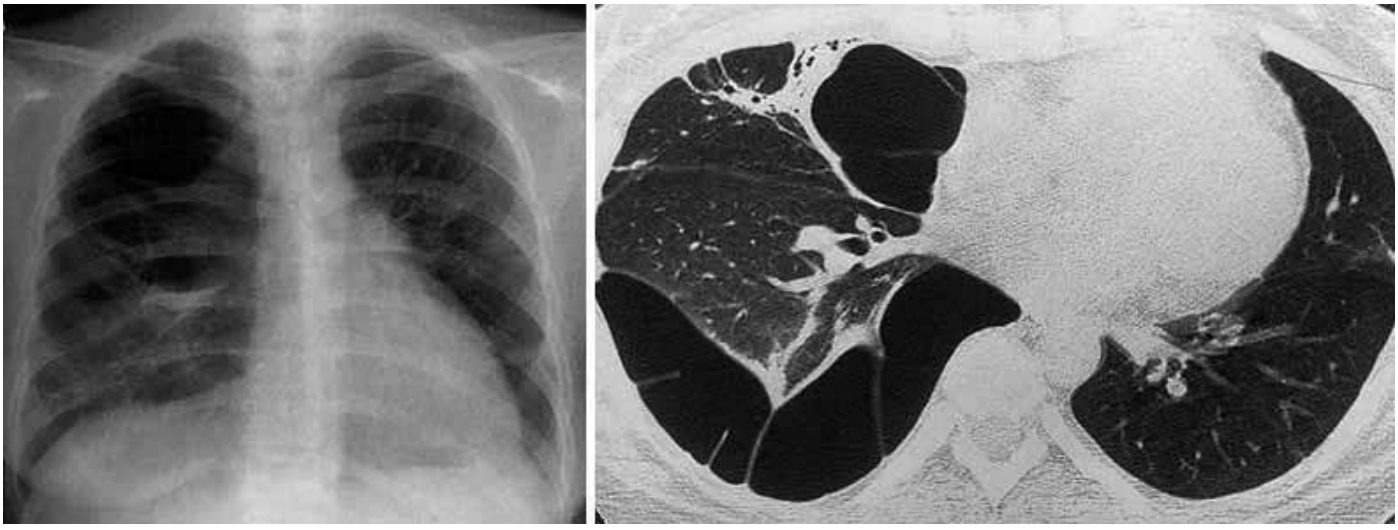


Fig. 5 : Classical staphylococcal pneumonia with diffused infiltrates and pneumatocele formation

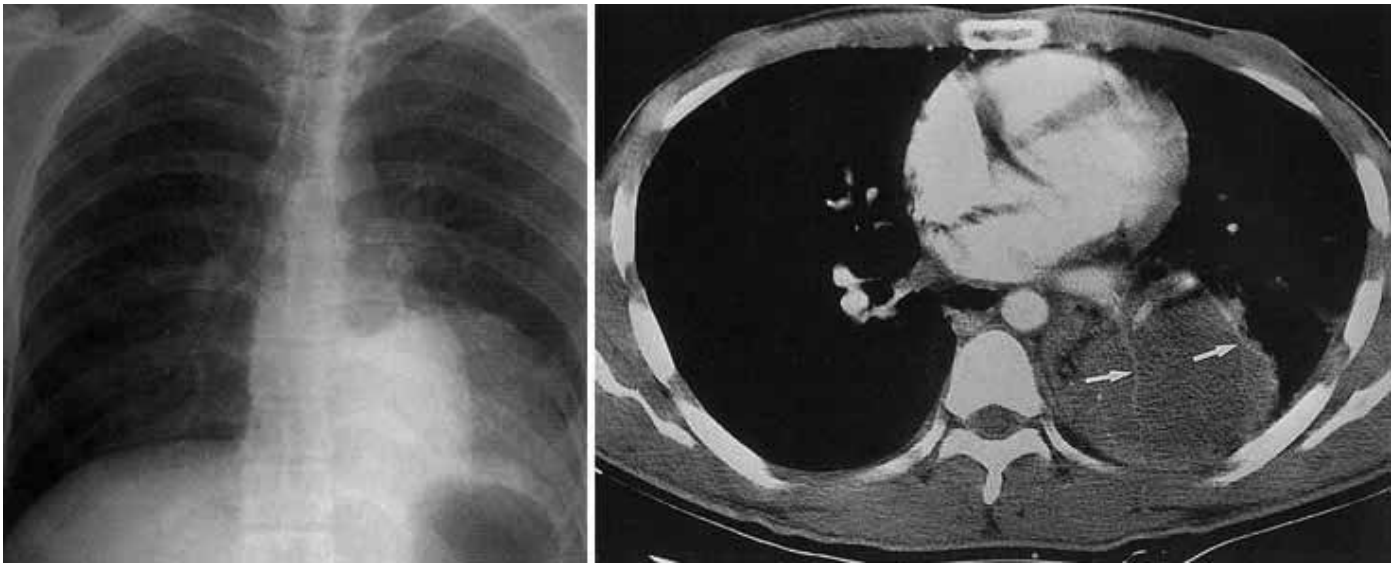


Fig. 6 : Klebsiella pneumonia - bulging fissures and cavitations due to intense exudation are characteristic.

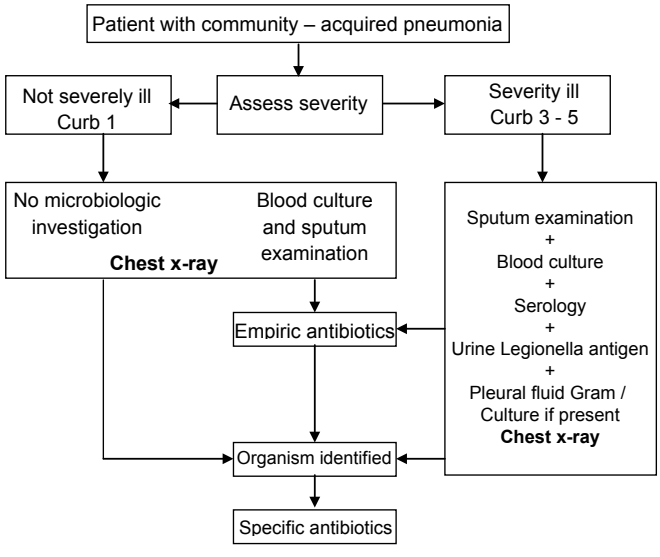


Fig. 7 : Summary of the Diagnostic Approaches

description of pneumonia by William Osler to understand the importance of the clinical presentation.

When seen on the second or third day, the picture in typical pneumonia is more distinctive than that presented by any other acute disease. The patient lies flat in bed, often on the affected side; the face Is flushed, particularly one or both cheeks; the breathing is hurried, accompanied often with a short expiratory grunt; the alae nasi dilate with each inspiration; herpes is usually present on the lips or nose; the eyes are bright, the expression is anxious, and there is a frequent short cough which makes the patient wince an d hold his side. The expectoration is blood tinged and extremely tenacious.

William Osler.

The Principles and Practice of Medicine.