



PATHOPHYSIOLOGY AND LABORATORY IDENTIFICATION OF PNEUMONIA

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This time of the year, two significant events happen to most respiratory therapists: They enjoy the holidays with family and friends, and patients start showing up in hospitals with pneumonia.

Each year, more than 4 million cases of pneumonia cost the U.S. somewhere between \$20 billion and \$30 billion. There are a number of ways to classify these pneumonias. Community-acquired pneumonia occurs when a person catches the disease outside the hospital and is admitted for treatment. Hospital-acquired pneumonia occurs when a person is admitted to the hospital for some other ailment, and then acquires pneumonia 48 hours or more after admission. The third classification, ventilator-associated pneumonia, is diagnosed in patients that acquire pneumonia within 48 to 72 hours after being intubated and placed on a ventilator.

Each year, 4 million cases of pneumonia cost the U.S. between twenty and thirty billion dollars

Pneumonia can be classified by the mechanisms through which patients acquire the disease. Did they inhale organisms that are known to cause pneumonia, or were they aspirated? Perhaps organisms were spread from the patient's own blood to their lungs or spread from adjacent organs such as the heart or abdomen. The final way, and the

one most important to care providers and patients, is what organism is responsible for the pneumonia.

Normally, pulmonary defense mechanisms such as the immune response, cough reflex, sneezing and mucociliary clearance protect individuals from pneumonia. When one of these defenses is compromised, that is prime time for pneumonia to take hold.

Pneumonia is often bacterial in etiology with *Streptococcus pneumoniae* leading the way with up to 70 percent or more of the infections we see in the hospital. *Haemophilus influenzae*, a Gram negative coccobacilli, is the cause of approximately 10 percent, as well as other enteric Gram negative rods also being responsible for about 10 percent. Other contributors are viruses, *Chlamydia* sp., *Staphylococcus aureus*, *Legionella* sp., *Mycobacterium tuberculosis*, *Mycoplasma* sp. and *Moraxella* sp.

After the organisms enter the lung, they multiply and trigger pulmonary inflammation. Alveolar air spaces fill with an exudative fluid, and inflammatory cells invade the alveolar septa. Bacterial pneumonia may be associated with significant V/Q mismatch and hypoxemia because inflammatory exudates collect in the alveolar spaces. These alveolar exudates tend to consolidate

and become difficult to expectorate. Viral pneumonia generally does not produce exudative fluids unless there is a superinfection with a secondary bacterial pneumonia.

Typical clinical manifestations include cough, often with sputum production of varying colors (yellow, green, blood-tinged), fever, dyspnea, pleuritic chest pain and gastrointestinal symptoms with nausea, diarrhea and vomiting. Some patients present with fever only. Crackles and bronchial breath sounds may be heard over the affected lung tissue. Patients may also have chills and an abnormal chest x-ray.

Consolidation may be seen with *Staphylococcus aureus*, *Haemophilus influenzae*, *Klebsiella pneumoniae*, and *Legionella* species. Patchy infiltrates can be seen with *Streptococcus pneumoniae*. In addition to infiltrates, *Pseudomonas aeruginosa* and *E. coli* infections may also show pleural effusions. Anaerobic organisms that cause pneumonia will tend to show infiltrates in dependent lung fields. An interesting organism is *Mycoplasma pneumoniae*, also called atypical pneumonia, because the chest X-ray can have very diffuse infiltrates or appear normal.

Lab identification

Laboratory identification of pneumonia generally consists of four common procedures: the complete blood count, blood and sputum cultures, and the chest x-ray. A very quick and helpful test is the Gram stain, which is part of the sputum culture.

Characteristics that are important to note on the sputum Gram stain are very few squamous epithelial cells (less than 25 per low power field, or one to two per high oil field). This is a good indication that you actually have sputum and not a spit specimen. Neutrophils (more than 25 per low power field or three to five per high oil field) are a good indicator that you have a bacterial infection.

Macrophages (more than one in any field) are a good indicator of an immune response. But the most significant part of the Gram stain is the presence of a homogenous distribution of bacteria, not a collection for three to five different types of organisms. This usually indicates a contaminated specimen. A good amount is a strong indication that what you are seeing in the microscope is actually causing the pneumonia.

Small Gram positive cocci in pairs are typical of *Streptococcus pneumoniae*, Gram positive cocci in long chains are characteristic of *Streptococcus pyogenes*. Large Gram positive cocci in clusters like grapes are characteristic of *Staphylococcus aureus*. Gram negative short coccobacilli are



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indicative of *Haemophilus influenzae*. All enteric bacteria such as *Klebsiella* sp., *Proteus* sp., *E. coli*, *Pseudomonas* sp., *Enterobacter* sp., all tend to have very uniform Gram negative rod structures. *Acinetobacter* sp. is the one exception being anaerobic and having a very thread-like appearance on Gram stain.

Anaerobic sp are also Gram positive or Gram negative, but only the culture will tell you whether they are aerobic or anaerobic. Yeast and fungus tend to be Gram positive in staining properties but vary morphologically depending on the species. On the Gram stain, they are big structures compared to the bacteria that may also be present on the slide.

The utility of the Gram stain is that the results can be available with 30 minutes of sputum collection. The physician can often make a presumptive diagnosis and start treatment at this point. Sputum cultures can give the definitive diagnosis but final results are available usually in three to five days (presumptive in one day) in the case of bacterial infections.

Different type of media are required to grow most bacteria since they can often be very fastidious in their growth pattern and nutritional requirements. The more fastidious organisms generally require longer incubation periods as well as more specialized media for growth. This will slow down the identification process.

In certain cases such as viral fungal infections, serologic tests may be indicated rather than culture. Viral and fungal cultures may take up to two weeks, and tuberculosis cultures up to six weeks.

The blood cell count is useful in differentiating between bacterial and viral infections. Bacterial infections will show an elevated white blood cell count with an increase in the percentage of neutrophils on the differential. The white blood count in viral pneumonia may be normal or elevated with an increase in lymphocytes on the differential with neutrophils generally being within normal range.

For pneumonias other than bacterial, the serology section of the chart can be useful. For example, patients with *Mycoplasma pneumoniae* infections, the presence of cold agglutinins is useful in diagnosis. A titer of 1 to 32 or greater can be seen in 50 percent to 90 percent of patients with confirmed *Mycoplasma pneumoniae* lower pulmonary tract infections.

Changes in antibody titer such as elevated IgG levels between acute and convalescent samples are useful to help incriminate a particular organism as the cause for the patient's pneumonia. These types of titers, however, can take weeks (two to eight weeks or more) to obtain results. Complement fixation, ELISA and immunofluorescent assays are commonly employed for this purpose. *Legionella* sp. and pneumococcal sp. antigens can be found in the patient's urine and help identify these difficult organisms.

PCR (polymerase chain reaction) is another tool used in the laboratory to amplify the amount of DNA from a small sample of microorganisms isolated from sputum culture or other body sources. Then, DNA sequencing can be done to give information about the genus and species of the organisms in question. EIA (enzyme immunoassay) is also useful in identifying enzyme patterns in microorganisms. The patient presenting with suspected pneumonia can be a challenge to the health care provider in terms of identifying a causative agent. Once identified, antibiotic sensitivity tests are performed to pinpoint the best antimicrobial agent to use in treating the pneumonia. Current medications include penicillin, macrolides, cephalosporins or quinolones.

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cially have the ability to “wrangle” a paid registration from a sales rep that they’ve done a lot of business with! Not only do those sales-reps get reduced-fee registrations, not only is the price of a reduced registration “small potatoes” in the context of the major sale they just made to you, but for them, the price of the reduced registration they purchased for you is totally deductible as a business expense!

Get your medical director involved. Ask him/her to write a letter/memo to your boss that urges him/her to send you to the conference from a “medical perspective” (difficult for an administrator to deny). Department Directors can also point to the Joint Commission requirement that states that at least the department’s manager should have relevant outside training opportunities provided to them, such as conferences.

And remember...in the very final analysis, your entire travel, lodging, food and registration fees involved in going to a professional conference directly related to your field, such as the FOCUS conference, are completely tax deductible. Thus, it may well be worth the investment in your own career to make the **personal** expenditure to attend, even if you cannot obtain financial help from your employer. As hard as it may be to do, we recommend that people put aside \$20 a week until the conference so that you’ll be half way there as regards having the funds necessary to attend. If you can then get at least **some** of the money from your employer, say, just the registration fee, with you picking up the rest of the expenses, you’ll be in good shape and able to attend. While on that note, also remember not to give up the ship just because they won’t pay your **entire** way. Ask them to pay at least **some** of the way if not all of it; perhaps just the registration fee or maybe just the travel expense with you picking up the rest (later deducting it on your tax returns.). Don’t be afraid to diplomatically point out that the institution has rarely or maybe even *never* sent you to a conference before (if that be the case) and so, your request is not excessive by any means.

Utilizing the above tips, will greatly increase your chance of getting at least **some** of the money needed to attend if not **all**. Remember, also, that in these tough times, our having the conference at Disney World in Orlando actually presents you with an **opportunity** to still have a family vacation that you might otherwise have to forgo in these tough times. Although still an expense, you and your family would probably not be able to “do” Disney as affordably as thru the FOCUS conference (Florida residents not included). We negotiated rooms at Disney for only \$129 per night and we negotiated up to *quad* occupancy for that same \$129 a night, rate. Staying at a Disney property also includes roundtrip transportation of you, your family and your luggage to and from the airport at no charge and free transportation to all of the parks including reduced pricing at those parks. All that Disney provides, combined with all that FOCUS will provide, does, really make for an extraordinary value! Follow these tips to the letter, be optimistic and provide a professional presentation of why you would like to go and you will greatly increase your chances of getting all or some of the funding necessary to attend. One you’re here you will love the conference and you will leave saying what 99.9% of previous attendees have said about the FOCUS conference, that is, that’s it’s a great conference and an extraordinary value. Good Luck in your efforts!

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In closing, it is important to mention one new pneumonia on the scene: severe acute respiratory syndrome. We know this one better by the name SARS, which first appeared in Asia in 2003. That year, the disease spread to more than two dozen countries in North America, South America, Europe and Asia before the global outbreak was contained. According to the World Health Organization, a total of 8,089 people became sick with SARS worldwide, and 774 died. Only eight confirmed SARS cases occurred in the U.S. during the epidemic.

SARS is caused by a coronavirus called SARS-associated coronavirus (SARS-CoV). The primary mode of transmission appears to be through close person-to-person contact, most likely through respiratory droplets that are produced when a person coughs or sneezes. The virus also can spread through contact with contaminated objects or surfaces followed by touching the mouth, nose, or eyes.

Patients present with viral pneumonia symptoms. The common laboratory tests that appear to be abnormal in this disease are lymphopenia with a normal or low white blood cell count, elevated liver enzymes, elevated creatine kinase, elevated lactate dehydrogenase and prolonged activated partial thromboplastin time. Definitive diagnosis requires laboratory confirmation of the virus from respiratory specimens, blood and stool. Current treatment is supportive in nature.

Pneumonia is a disease that has been around for decades, but it still has the ability to present a challenge to the health care practitioner.

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