Introduction

Pneumonia is considered a major healthcare and economic problem with a considerable effect on morbidity and mortality worldwide. It is the sixth leading cause of death and the most common infectious cause of death worldwide, with an age-adjusted mortality up to 22%. Community-acquired pneumonia in adults is a common disorder, potentially life threatening, with a high hospitalization rate ***(Almirall et al., 2000 & Lancet, 2003).*** It is the only acute respiratory tract infection in which delayed antibiotic therapy has been associated with increased risk of death ***(Meehan et al., 1997)***. Therefore, a correct and rapid diagnosis is mandatory.

Pneumonia is also an important health-care related complication: it is the second most common type of nosocomial infection and has the highest mortality. Due to this high burden, physicians with patients suspected of pneumonia are constantly challenged to determine if the clinical syndrome is pneumonia rather than alternative diagnosis ***(Lichtenstein, 2009).***

The incidence of community-acquired pneumonia has remained constant over the last few decades affecting 3-5 people per 1000 person-years, predominantly among the young and elderly. An adequate treatment is reliant on early diagnosis of pneumonia, yet the diagnosis is not always clear at presentation ***(National Center for Health Statistics, 2006).***

Rates are greatest in children less than five and adults older than 75 years of age. It occurs about five times more frequently in the developing world versus the developed world. Viral pneumonia accounts for about 200 million cases ***(File, 2003 & Almirall et al., 2000)***.

More cases of community acquired pneumonia occur during the winter months than at other times of the year. It is estimated that 2.3 million cases of CAP lead to more than 10 million physician visits, 500 000 hospitalizations and 45 000 deaths each year in the United States. Mortality rates for CAP vary from 1% for patients with mild disease who do not need to be hospitalized to more than 30% for those with more severe disease who require hospitalization. Individuals with underlying chronic illnesses, such as Alzheimer's disease, cystic fibrosis, emphysema, and immune system problems as well as tobacco smokers, alcoholics, and individuals who are hospitalized for any

reason, are at significantly increased risk of contracting, and having repeated bouts of, pneumonia ***(Murray & Mills, 1990).***

The current imaging modalities used to diagnose pneumonia include chest x-ray and CT. Chest x-ray is the main imaging approach in many settings, and is easier to perform; however limitations for its use exist. For example, radiation exposure precludes CXR use in pregnant women ***(Reissig et al., 2012).*** A chest x-ray is completed during approximately 18.5% of all emergency department visits in the United States, with an estimated 20.4 million ED CXRs performed annually ***(Mc Caig et al., 2004).*** When evaluating patients with chest symptoms, such as shortness of breath, chest pain and cough, emergency clinicians must decide if CXR findings are consistent with pneumonia. Failure to promptly recognize and treat bacterial pneumonia may lead to significant morbidity and mortality ***(Garnacho-Mantero et al., 2010 & Mandell et al., 2007).*** Meanwhile, inappropriate use of antibiotics for respiratory symptoms not caused by bacterial infection is likely a major contributor to the development of antibiotic resistance ***(Chen et al., 1999 & Lipsitch et al., 2002).*** Furthermore, attributing a patient's symptoms to pneumonia based on CXR results when, in fact, pneumonia is not

present may lead to diagnostic anchoring and failure to recognize the patient's true illness ***(Sibinga and Wu, 2010).***

Pulmonary opacities, areas of increased attenuation visualized within the lung fields on chest imaging, are commonly used as criteria to support the diagnosis of pneumonia ***(Tuddenham, 1984 & Austin et al., 1996).*** Despite Chest x-ray being used as the primary radiographic test to evaluate for pneumonia, the test characteristics of chest x-ray for detecting pneumonia are not well understood. Moreover, it is frequently troublesome to acquire both postero-anterior and latero-lateral projections in hospitalized patients, especially among the critically-ill ***(Self et al., 2013).*** Finally, CXR can be a time consuming procedure and its interpretation has high inter-observer variability among radiologists ***(Mayo et al., 2013 & Brenner & Hall, 2007).*** Computed Tomography is a more precise technique for imaging the chest, but has not supplanted Chest x-ray as the primary imaging test for pneumonia due to increased time, cost, and radiation exposure associated with CT ***(Wheeler & Fishman, 1996 & Syrjala, 1998).***

Ultrasonography is a fast and non-invasive investigation. Use of lung ultrasound has long been limited to the diagnosis of pleural effusions, thoracentesis and

biopsy-guided procedures; however it has recently been shown to be highly effective in evaluating pulmonary conditions such as pneumonia and pneumothorax ***(Lichtenstein, 2009 & Cortellaro et al., 2012).*** The use of Lung ultrasound has gained popularity in Intensive care units and Emergency Departments in the last decade, and has become increasingly recognized as a potentially useful diagnostic approach for CAP. At present, the diagnosis of CAP via bedside ultrasonography mainly depends on detecting consolidation. However, CAP patients do not always have consolidation, but may have interstitial pneumonia or diffuse pulmonary infiltrations. Even if consolidation is not detected, other abnormalities could be found by ultrasonography, such as focal interstitial pattern, pleural-line abnormalities and subpleural lesions ***(Hagaman et al., 2009).***

To date, only a few studies have investigated the use of lung ultrasound in the diagnosis of pneumonia in the Emergency Department or ICU.

Aim of the Work

This study will assess the value of Chest U/S in early detection & follow up of Pneumonia, comparing its sensitivity & specificity with CT chest in diagnosis & detection of resolution.

Pneumonia

Pneumonia is a common illness affecting approximately 450 million people a year and occurring in all parts of the world ***(Kabra et al., 2010).*** It is a major cause of death among all age groups resulting in 4 million deaths. Bacterial pneumonia is the sixth most common cause of death in the USA ***(Fine et al., 1996 & Almirall et al., 1996).***

Rates are greatest in children less than five and adults older than 75 years of age. It occurs about five times more frequently in the developing world versus the developed world. Viral pneumonia accounts for about 200 million cases ***(Kabra et al., 2010).***

More cases of community acquired pneumonia occur during the winter months than at other times of the year. It is estimated that 2.3 million cases of CAP lead to more than 10 million physician visits, 500 000 hospitalizations and 45 000 deaths each year in the United States. Mortality rates for CAP vary from 1% for patients with mild disease who do not need to be hospitalized to more than 30% for those with more severe disease who require hospitalization. Fine performed a meta-analysis showing that 14% to 35% of

hospitalized CAP patients do not survive ***(Fine et al., 1996)***.

Pneumonia occurs more commonly in males than in females, and more often among Blacks than Caucasians, partly due to quantitative differences in synthesizing Vitamin D after exposure to sunlight **(*Kabra SK et al., 2010*)**.

Individuals with underlying chronic illnesses, such as Alzheimer's disease, cystic fibrosis, emphysema, and immune system problems as well as tobacco smokers, alcoholics, and individuals who are hospitalized for any reason, are at significantly increased risk of contracting, and having repeated bouts of, pneumonia ***(Murray & Mills, 1990)***.

Pneumonia can be generally defined as inflammation of the lung parenchyma, in which consolidation of the affected part and a filling of the alveolar air spaces with exudate, inflammatory cells, and fibrin is characteristic. Infection by bacteria or viruses is the most common cause, although inhalation of chemicals, trauma to the chest wall, or infection by other infectious agents such as rickettsiae, fungi, and yeasts may occur ***(Lyon et al., 1996).***

Bacterial pneumonias were previously classified into lobar pneumonia, bronchopneumonia and acute interstitial pneumonia. This classic morphologic classification cannot help to predict the causative organism. The spectrum of organisms is ever increasing; continued escalation in the elderly population of our society and widespread use of antibiotics have changed patterns of bacterial pneumonias ***(Respirology, 2006).*** Therefore, most authors prefer a clinical classification of pneumonia: community-acquired pneumonia (CAP), aspiration pneumonia, healthcare-associated pneumonia (HCAP), nosocomial pneumonia [hospital acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP)]. The number of immunocompromised patients has dramatically increased because of the AIDS epidemic, cancer chemotherapy, and organ transplantation. Over the last few years many viral infections, such as systemic acute respiratory syndrome and avian influenza, have become a significant threat to humans ***(Dean et al., 2006 & Van der Poll & Opal, 2009).***

Diagnosis of pneumonia requires a combination of clinical assessment, radiological imaging, and appropriate microbiological tests ***(Solvis et al., 2004).***

Clinical presentation:

During the history taking, the patient's potential exposures, aspiration risks, host factors, and symptoms should be reviewed.

Potential exposures

A history of various exposures, such as travel, animals, occupational exposures, and environmental exposures, can be helpful in determining possible etiologies and the likelihood of bacterial pneumonia, as follows:

- Exposure to contaminated air-conditioning or water systems – *Legionella* species.
- Exposure to overcrowded institutions (e.g. jails, homeless shelters) - S pneumoniae, Mycobacteria, Mycoplasma, Chlamydophila.
- Exposure to various types of animals - Cats, cattle, sheep, goats (*C* burnetii, B anthracis [cattle hide]; turkeys, chickens, ducks, or other birds (C psittaci); rabbits, rodents (F tularensis, Y pestis).

Aspiration risks

Patients at increased risk of aspiration are also at increased risk of developing pneumonia secondarily. Associated factors are as follows:

- Alcoholism.
- Altered mental status.
- Anatomic abnormalities, congenital or acquired.
- Dysphagia.
- Gastroesophageal reflux disease (GERD).
- Seizure disorder.

Additional host factors

- Co-morbid conditions (e.g. asthma, COPD, smoking, and a compromised immune system are risk factors for H influenzae infection).
- Previous surgeries.
- Possibility of immunosuppression.

Symptoms

The clinical presentation of bacterial pneumonia varies. Sudden onset of symptoms and rapid illness progression are associated with bacterial pneumonias. Chest pain, dyspnea, hemoptysis, decreased exercise tolerance, and abdominal pain from pleuritis are also highly indicative of a pulmonary process.

The presence of cough, particularly cough productive of sputum, is the most consistent presenting symptom. Although not diagnostic of a particular causative agent, the

character of the sputum may suggest a particular pathogen, as follows:

- S pneumoniae is classically associated with a cough productive of rust-colored sputum.
- Pseudomonas, Haemophilus, and pneumococcal species may produce green sputum.
- Klebsiella species pneumonia is classically associated with a cough productive of red currant-jelly sputum.
- Anaerobic infections often produce foul-smelling or bad-tasting sputum.

Nonspecific symptoms such as fever, rigors or shaking chills, and malaise are common. For unclear reasons, the presence of rigors may suggest pneumococcal pneumonia more often than pneumonia caused by other bacterial pathogens ***(Claudius I & Baraff, 2010).*** Other nonspecific symptoms that may be seen with pneumonia include myalgias, headache, abdominal pain, nausea, vomiting, diarrhea, anorexia and weight loss, and altered sensorium ***(Brown et al., 2009).***

Pertussis is often characterized by its long course of symptomatic cough in adults and by the presence of a whooping sound and/or post-tussive vomiting in children.

Pneumonia from H. influenzae most commonly arises in the winter and early spring. This pneumonia is more often associated with hosts who are debilitated.

Patients with Legionella pneumonia often present with mental status changes or diarrhea. Patients may develop hemoptysis or pulmonary cavitations. In addition, unlike other pneumonias, more than 50% of the time Legionella pneumonia has gastrointestinal (GI) symptoms associated with it, such as anorexia, nausea, vomiting, and diarrhea. Hyponatremia is often noted.

L. pneumophila seems to have 2 forms: Pontiac fever and frank Legionella pneumonia. Pontiac fever has a virus-like presentation, with malaise, fever and/or chills, myalgias, and headache. This form of Legionella pneumonia usually subsides without sequelae. However, frank Legionella pneumonia is very aggressive, with a mortality rate as high as 75% unless treatment begins rapidly. This form occurs in individuals who are elderly and debilitated, as well as in smokers and those with COPD, alcoholism, immunocompromise, or trauma.

Physical Examination

Physical examination findings may vary, depending on the type of organism, severity of infection, coexisting host factors, and the presence of complications ***(Brown et al., 2009 & Fang et al., 2011)***.

Signs of bacterial pneumonia may include the following: ***(Lim et al., 2003)***

- Hyperthermia (fever, typically >38°C) or hypothermia (< 35°C).
- Tachypnea (>18 respirations/min).
- Use of accessory respiratory muscles.
- Tachycardia (>100 bpm) or bradycardia (< 60 bpm).
- Central cyanosis.
- Altered mental status.

Physical findings may include the following:

- Adventitious breath sounds, such as rales /crackles, rhonchi, or wheezes.
- Decreased intensity of breath sounds.
- Egophony.
- Dullness to percussion.
- Tracheal deviation.
- Lymphadenopathy.
- Pleural friction rub.

Examination findings that may indicate a specific etiology for consideration are as follows:

- Bradycardia may indicate a Legionella etiology.
- Periodontal disease may suggest an anaerobic and/or polymicrobial infection.
- Bullous myringitis may indicate Mycoplasma pneumoniae infection.
- Physical evidence of risk for aspiration may include a decreased gag reflex.
- Cutaneous nodules, especially in the setting of central nervous system (CNS) findings may suggestion Nocardia infection.

Risk Stratification

Severity-of-illness scores or prognostic models, such as the CURB-65 criteria or the Pneumonia Severity Index (PSI) can be used to help identify patients that may be candidates for outpatient treatment and those that may require admission. The Infectious Disease Society of America (IDSA) and American Thoracic Society (ATS) proposed guidelines and criteria to determine the severity of community-acquired pneumonia (CAP), which would affect whether inpatient treatment would occur on the ward or require ICU care ***(Fine et al., 1997).*** Although many of