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Clinical association of bacteriological, radiological and clinical findings in children suffering from pneumonia

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Abstract
Pneumonia results in more than 500,000 hospital admissions annually in adults and ranks as the sixth leading cause of death in United States. The problem is much greater in developing countries where pneumonia is the most common cause of hospital attendance in adults. Physicians need reliable data on the relative prevalence of different etiological agents in the patients' area of residence, in addition to the clinical, laboratory and radiological findings in order to initiate antibiotic treatment empirically. The relative frequency of etiological agents varies among different geographical areas. Hence based on these findings the present study was planned for Clinical Association of Bacteriological, Radiological and Clinical Findings in Children Suffered from Pneumonia.
The present study was planned in Department of Paediatrics, Government Medical College, Bettiah, West Champaran, Bihar. Total 50 Children in the aged 1 to 5 years with clinical signs suggestive of pneumonia were included in the study, as per WHO guidelines. A detailed history of the relevant symptoms such as fever, cough, rapid breathing, refusal of feeds, noisy breathing and bluish discolouration were considered. Based on WHO ARI criteria, children with tachypnea were considered.
The data generated from the present study concludes that Routine haematological investigations and blood culture will not give much information regarding severity or etiology of illness. Chest X-ray is valuable aid in the diagnosis of pneumonia in children. Also clinical diagnosis by WHO ARI criteria are very sensitive and can be applied to hospitalized children. Application of molecular diagnostic techniques has the potential to lead to more targeted therapy in the face of increasing antibiotic resistance. The advent of conjugate vaccines against Bacteria- Pneumococcus, H. Influenza, and Viruses- Influenza could help reduce burden of the disease in the community.

Keywords: bacteriological, radiological, clinical, pneumonia, etc

Introduction
The United Nations Children's Fund (UNICEF) estimates that pediatric pneumonia kills 3 million children worldwide each year. These deaths occur almost exclusively in children with underlying conditions, such as chronic lung disease of prematurity, congenital heart disease, and immunosuppression. Although most fatalities occur in developing countries, pneumonia (see the image below) remains a significant cause of morbidity in industrialized nations. Pneumonia can occur at any age, although it is more common in younger children. Pneumonia accounts for 13% of all infectious illnesses in infants younger than 2 years.
Newborns with pneumonia commonly present with poor feeding and irritability, as well as tachypnea, retractions, grunting, and hypoxemia. Infections with group B Streptococcus, Listeria monocytogenes, or gram-negative rods (eg, Escherichia coli, Klebsiella pneumoniae) are common causes of bacterial pneumonia. Group B streptococci infections are most often transmitted to the fetus in utero. The most commonly isolated virus is respiratory syncytial virus (RSV). Cough is the most common symptom of pneumonia in infants, along with tachypnea, retractions, and hypoxemia. These may be accompanied by congestion, fever, irritability, and decreased feeding. Streptococcus pneumoniae is by far the most common bacterial pathogen in infants aged 1-3 months.
Adolescents experience similar symptoms to younger children. They may have other constitutional symptoms, such as headache, pleuritic chest pain, and vague abdominal pain. Vomiting, diarrhea, pharyngitis, and otalgia/otitis are also common in this age group. Mycoplasma pneumoniae is the most frequent cause of pneumonia among older children and adolescents. The signs and symptoms of pneumonia are often nonspecific and widely vary based on the patient's age and the infectious organisms involved. Observing the child's respiratory effort during a physical exam is an important first step in diagnosing pneumonia. The World Health Organization (WHO) respiratory rate thresholds for identifying children with pneumonia are as follows [1]:

- Children younger than 2 months: Greater than or equal to 60 breaths/min
- Children aged 2-11 months: Greater than or equal to 50 breaths/min
- Children aged 12-59 months: Greater than or equal to 40 breaths/min

Assessment of oxygen saturation by pulse oximetry should be performed early in the evaluation when respiratory symptoms are present. Cyanosis may be present in severe cases. Capnography may be useful in the evaluation of children with potential respiratory compromise. Initial priorities in children with pneumonia include the

identification and treatment of respiratory distress, hypoxemia, and hypercarbia. Grunting, flaring, severe tachypnea, and retractions should prompt immediate respiratory support. Children who are in severe respiratory distress should undergo tracheal intubation if they are unable to maintain oxygenation or have decreasing levels of consciousness. Increased respiratory support requirements such as increased inhaled oxygen concentration, positive pressure ventilation, or CPAP are commonly required before recovery begins.

The majority of children diagnosed with pneumonia in the outpatient setting are treated with oral antibiotics. High-dose amoxicillin is used as a first-line agent for children with uncomplicated community-acquired pneumonia. Second- or third-generation cephalosporins and macrolide antibiotics such as azithromycin are acceptable alternatives. Combination therapy (ampicillin and either gentamicin or cefotaxime) is typically used in the initial treatment of newborns and young infants.

Hospitalized patients can also usually be treated with a narrow-spectrum penicillin such as ampicillin. The choice of agent and dosing may vary based on local resistance rates (high rates of intermediate or resistant pneumococcus may require higher dosing of ampicillin to surmount the altered penicillin-binding protein that is the cause of resistant pneumococcus). In areas where resistance is very high (>25% of strains being nonsusceptible), a third-generation cephalosporin might be indicated instead. Older children, in addition, may receive a macrolide to cover for atypical infections. Although the fluoroquinolones would cover all the common respiratory pathogens of childhood, they are not approved for this indication and have significant potential adverse effects, including short-term tendon damage and long-term impact on antibiotic resistance. They should be reserved for cases in which other therapies have failed and ideally should be used after consultation with an infectious disease specialist with whom other options, or alternative diagnoses, can be considered. Children who are toxic appearing should receive antibiotic therapy that includes vancomycin (particularly in areas where penicillin-resistant pneumococci and methicillin-resistant S aureus [MRSA] are prevalent) along with a second- or third-generation cephalosporin.

Aside from avoiding infectious contacts (difficult for many families who use daycare facilities), vaccination is the primary mode of prevention. Influenza vaccine is recommended for children aged 6 months and older. The pneumococcal conjugate vaccine (PCV13) is recommended for all children younger than 59 months old. The 23-valent polysaccharide vaccine (PPV23) is recommended for children 24 months or older who are at high risk of pneumococcal disease.

Pneumonia and other lower respiratory tract infections are the leading causes of death worldwide. Because pneumonia is common and is associated with significant morbidity and mortality, properly diagnosing pneumonia, correctly recognizing any complications or underlying conditions, and appropriately treating patients are important. Although in developed countries the diagnosis is usually made on the basis of radiographic findings, the World Health Organization (WHO) has defined pneumonia solely on the basis of clinical findings obtained by visual inspection and on timing of the respiratory rate.

Pneumonia may originate in the lung or may be a focal complication of a contiguous or systemic inflammatory process. Abnormalities of airway patency as well as alveolar ventilation and perfusion occur frequently due to various mechanisms. These derangements often significantly alter gas exchange and dependent cellular metabolism in the many tissues and organs that determine survival and contribute to quality of life. Recognition, prevention, and treatment of these problems are major factors in the care of children with pneumonia.

One particular form of pneumonia present in the pediatric population, congenital pneumonia, presents within the first 24 hours after birth. For more information, see Congenital Pneumonia. Other respiratory tract diseases such as croup (laryngotracheobronchitis), bronchiolitis, and bronchitis are beyond the scope of this article and are not discussed further. An inhaled infectious organism must bypass the host's normal nonimmune and immune defense mechanisms in order to cause pneumonia. The nonimmune mechanisms include aerodynamic filtering of inhaled particles based on size, shape, and electrostatic charges; the cough reflex; mucociliary clearance; and several secreted substances (eg, lysozymes, complement, defensins). Macrophages, neutrophils, lymphocytes, and eosinophils carry out the immune-mediated host defense.

Infections of respiratory tract are perhaps the most common human ailment. While they are a source of discomfort, disability and loss of time for most adults, they are a substantial cause of morbidity and mortality in young children [2]. Acute respiratory infections (ARI) are one of the commonest causes of death in children in developing countries. It is responsible for an estimated 4 million deaths worldwide. Almost all ARI deaths in young children are due to acute lower respiratory tract infections (ALRTI), mostly pneumonia [3].

Modernization, industrialization and urbanization are now posed with the problem of increase in ARI morbidity and mortality. It is clear that future health of children depends on preventing, diagnosing, treating and limiting ALRTI. The utility of simple clinical signs like rapid breathing and chest in drawing to diagnose pneumonia in infants and young children has been well established. The use of these clinical signs in the early detection and treatment of children with pneumonia by primary health care workers forms the basis for the case management strategy formulated by the World health organization (WHO) to control mortality and morbidity [4]. Empirical antibiotic therapy for pneumonia is the commonly accepted practice world-wide as the etiology of pneumonia in children is difficult to establish. Clinical and radiological criteria do not accurately reflect the etiology of childhood pneumonia [5].

ARI can be preventable. However socio environmental factors are acting as major obstacles in prevention of ARI. The epidemiological information regarding risk factors and management is scanty. A large gap exists in our knowledge about these factors, which needs to be fulfilled by systematic studies.

Pneumonia results in more than 500,000 hospital admissions annually in adults and ranks as the sixth leading cause of death in United States. The problem is much greater in developing countries where pneumonia is the most common cause of hospital attendance in adults. Physicians need reliable data on the relative prevalence of different etiological agents in the patients' area of residence, in addition to the clinical, laboratory and radiological findings

in order to initiate antibiotic treatment empirically. The relative frequency of etiological agents varies among different geographical areas [6]. Hence based on these findings the present study was planned for Clinical Association of Bacteriological, Radiological and Clinical Findings in Children Suffered from Pneumonia.

Methodology

The present study was planned in Department of Paediatrics, Government Medical College, Bettiah, West Champaran, Bihar. Total 50 Children in the aged 1 to 5 years with clinical signs suggestive of pneumonia were included in the study, as per WHO guidelines [7]. A detailed history of the relevant symptoms such as fever, cough, rapid breathing, refusal of feeds, noisy breathing and bluish discolouration were considered. Based on WHO ARI criteria, children with tachypnea were considered.

Various blood investigations such as hemoglobin percentage, total as well as differential WBC counts, ESR were done in all cases. Chest Xray, blood culture was done for all the participants. Based on radiological findings, children were divided into Bacterial (consolidations, alveolar infiltrates) and Viral (interstitial infiltrates, hyper aeration) pneumonia.

All the patients were informed consents. The aim and the objective of the present study were conveyed to them. Approval of the institutional ethical committee was taken prior to conduct of this study.

Following was the inclusion and exclusion criteria for the present study.

Inclusion criteria: Children between 2 months to 5 years with clinical features of severe pneumonia as per WHO guideline were included in the study.

Exclusion criteria: Children with congenital anomalies of heart and lungs, anatomical defects like cleft lip and claft palate, immunocompromised states and infants less than 2 months of age were excluded from the study.

Results & Discussion

The 2014 Pneumonia and Diarrhoea Progress Report released by the International Vaccine Access Centre at Johns Hopkins Bloomberg School of Public health, highlights persisting burden of pneumonia in India [8]. Community acquired pneumonia remains a common and serious illness despite the availability of potent new anti-microbial and effective vaccines. In the recent years both the epidemiology and treatment of pneumonia have undergone changes. Pneumonia is increasingly common in older patients associated with comorbidities like COPD, Diabetes, Renal Failure, Congestive heart failure, CLD and other conditions [9]. Previous studies in other centres in India4 have observed an increased incidence of CAP in patients above the age of 50 years while in our population 65% of the patients were below the age of 50 years most of which were daily wage workers and from poor socio economic strata. The risk factors include smoking, alcoholism and other associated co morbidities including COPD and Diabetes [10, 11].

Table 1: age and gender wise distribution of all cases

Age group (months)	Male	Female	Total
2 – 6	10	8	18
7 – 12	4	3	7
13 – 60	11	14	25
Total	25	25	50

Table 2: Presenting symptoms and signs in the all cases

Symptoms & Signs	Numbers of Cases
Cough	50
Fast breathing	50
Chest retractions	50
Fever	49
Crepitations	39
Ronchi	26
Abnormal breath sounds	12
Refusal of feeds	10
Wheeze	7
Convulsions	2
Cyanosis	2

Table 3: mean duration and range of symptoms/signs.

Symptoms/signs	Numbers	Duration in hospital (days)	Range (days)
Cough	50	2 – 10	2 – 28
Fever	49	3 – 8	1 – 20
Tachypnea	50	2 – 4	1 – 10
Chest retraction	50	1 – 4	1 – 10
Added sounds (crepitation/ronchi)	32	4 - 6	0 – 14

Table 4: Respiratory rate at the time of admission.

2 – 12 months	>80/min	60 – 80/min	<60/min
No. of child	01	21	3
13 – 60 months	>/min	50 – 60/min	40 – 50/min
No of child	13	11	01

Table 5: Clinical and radiological finding comparison of all cases.

Clinical data	No.	Radiological findings	
		Positive findings	Normal
Tachypnea	50	41	9
Chest retractions	50	40	9
Crepitations only	15	12	3
Crepitations + ronchi	25	22	3
Ronchi only	2	1	1
Abnormal breath sound	6	6	0

Table 6: Laboratory findings in comparison with radiological findings of all cases.

Findings	Total	Bacterial (94)	Viral (17)
Total	**50**	**31**	**5**
WBC >1500/cumm	50	20	3
DC neutrophilia	50	26	2
ESR >20mm/hr	50	29	3

Mishra S *et al.* [12] studies the result of ARI control programme in 100 hospitalized children. All cases with severe pneumonia survived. A mortality of 7.7% was seen

in case of very severe pneumonia. 6 patients were cases of staphylococcal pneumonia, out of which one died.

The duration of stay in hospital was significantly less in cases of severe pneumonia 4.21±1.59days as compared to very severe pneumonia which was 9.35 ± 1.59days. The data from the study suggests that the treatment protocol of the ARI control programme for hospitalized children is reasonably effective and can be implemented.

Gupta D *et al*. [13] in their hospital based prospective study have found that, fast breathing as most useful sign predicting pneumonia in all age groups. Cut off points at 50 breaths/min for infants including neonates, 40 breaths/min for children aged 12-35 months and 30 breaths/min for children aged 36-60 months indicated presence of pneumonia. They also found that, Crepitations on ausculatation were found to have good correlation with presence of pneumonia. They also found that, crepitations on auscultation were found to have good correlation with presence of radiological pneumonia.

Kumar N *et al*. [14] clinically evaluated acute respiratory distress and chest wheezing in infants. They found that presence of fever >1000 F, neutrophilia and opacities on chest X –ray find to the diagnosis of brochopneumonia in an infants with respiratory distress and chest wheezing. They also found absence of fever with normal leukocyte count or lymphocytosis point towards bronchiolitis in infants with respiratory distress at chest wheezing.

Drummond P. *et al*. [15] did a prospective study on etiology and most useful diagnostic tests for community acquired pneumonia in children. They isolated pathogens in 60% of cases. Viral infection accounted for 71% of cases diagnosed. Group A streptococcus was the most common bacterial agent with a low incidence of both mycoplasma pneumonia and streptococcus pneumonia. Pnemococcal pneumonia was the most common bacterial causes of pneumonia in children under two years of age. Inflammatory markers and chest X-ray infiltrates did not differentiate viral from bacterial pneumonia. They also found that serology and viral immunofluorosence were the most useful diagnostic tests.

Hamid M *et al*. [16] conducted a study on clinical, nutritional and radiological features of pneumonia. They found that 17 children had severe pneumonia, 77 children had very severe and 6 had pneumonia. 60% had radiological evidence of pneumonia. 89% of the cases responded to standard recommended treatment and only 11% required a change of therapy. Lack of breast feeding, low socio economic status, illiteracy and malnutrition were the significant risk factors. They concluded that the national ARI control guidelines for diagnosis, management of hospitalized children are simple, useful and effective.

Heaton P *et al*. [17] have conducted a study to determine whether chest radiography was clinical useful in the follow up of uncomplicated pneumonia. 93% of children had radiological evidence of pneumonia. 63% of children were followed up both clinically and radiologically between four and six weeks after discharge. 90% of the cases had no abnormal symptoms or signs and normal chest radiographs. 10% showed either slight resolution or no change from the admission films. Thus they concluded that, in cases of uncomplicated pneumonia, follow up chest radiography should be deferred until at least four weeks after discharge, and is not indicated with symptoms and signs are absent.

Zukin DD *et al*. [18] correlated pulmonary signs and symptoms with chest radiographs in the pediatric age group. They found that the sign with highest positive and negative predictive value for the presence of any radiographic abnormalities was tachypnoea. Absence of fever suggests absence of pneumonia, while chest examination findings other than wheezing, cough, prolonged expiration, or ronchi significantly increased the likelihood of pneumonia. Thus they concluded that physical examination findings could help the clinical determine the need for chest radiography in pediatric emergency patient.

Devies HD *et al*. [19] conducted a study to determine the reliability of detecting features and making diagnosis of lower respiratory infections from chest radiograms in infants. The examined features were hyperinflation, peribronchial thickening perihilar linear opacities, atelectasis and consolidations. They noticed that there is variation in interobserver and intra observer agreement among radiologists on the radiographic features used for diagnosis. They concluded that the presence of consolidations highly correlated with a diagnosis of air space disease.

Kabra SK *et al*. [20] studied the etiology of ALRTI in under five children by non- invasive methods. They identified etiological agents in 94% of the patients. Viruses were isolated from nasopharyngeal aspirate in 38% bacteria from blood cultures in 16%, mycoplasma in 24% and Chlamydia in 11%. They concluded that noninvasive methods are useful in identifying etiological agents in severe ALRTI.

Broor S *et al*. [21] studied the risk factors for severe ALRTI in under five children. They concluded that lack of breast feeding, under respiratory tract infection in mother, upper respiratory tract infection in siblings, severe malnutrition, cooking fuel other than liquid petroleum gas, in appropriate immunization for age and history of ALRTI in family were significant risk factor.

Rahman MM *et al*. [22] studied the prevalence of acute respiratory tract infection and its risk factors among under five children in a rural community. The prevalence or ARI was 58.7%, with mean number of episodes of ARI being 1.75 per child per year. The risk factors were malnutrition, illiteracy, poverty, overcrowding and parental smoking. Thus they concluded that there is need for research aimed at health system to determine the most appropriate approaches to control ARI and thus could be utilized to strengthen the ARI control programme.

In developing countries childhood pneumonias are diagnosed using clinical parameters only. Although this is cheap, sensitive and maximizes the number of children identified and treated empirically, it is also nonspecific and highly dependent on the context in which it is being applied [23]. The simple chest radiograph has been an important investigative tool in the diagnoses of diseases, since the discovery of X-rays in late nineteenth century. Though new techniques in radiology such as CT scan, MRI, have improved the diagnostic abilities of physicians, plain radiography of the chest still remains the most commonly utilized tool for pediatricians in diagnosing pneumonia and other respiratory conditions [24]. The standard test for diagnosis of patients is a 2 view plain chest radiograph. However when chest radiographs are subjected to blinded readings they may not differentiate between viral disease and bacterial disease. Although unilateral and or lobar infiltrates are often seen in bacterial pneumonia, several studies have found the pattern of radiologic features could not accurately distinguish a bacterial etiology from a viral

etiology. In contrast a large Finnish series concluded that an alveolar (equivalent to a lobar) infiltrate is an insensitive but reasonably specific indication of bacterial infection [25].

Conclusion

The data generated from the present study concludes that Routine haematological investigations and blood culture will not give much information regarding severity or etiology of illness. Chest X-ray is valuable aid in the diagnosis of pneumonia in children. Also clinical diagnosis by WHO ARI criteria are very sensitive and can be applied to hospitalized children. Application of molecular diagnostic techniques has the potential to lead to more targeted therapy in the face of increasing antibiotic resistance. The advent of conjugate vaccines against Bacteria- Pneumococcus, H. Influenza, and Viruses- Influenza could help reduce burden of the disease in the community.

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