DOI: 10.7860/JCDR/2013/5132.3222

Original Article

Infectious Diseases Section

The Association of Positive Chest Radiograph and Laboratory Parameters with Community Acquired Pneumonia in Children

DHAIRYA LAKHANI[1], PRASAD MULEY[2]

ABSTRACT

Context: This study was designed to compare the sensitivities of different investigations for the diagnosis of Community Acquired Pneumonia (CAP). A prospective study was carried out which compared the sensitivities of the chest radiographs, CRP, TLC, ESR and the blood cultures in sixty-six patients who were diagnosed with WHO defined CAP.

Material and Methods: The chest radiographs, serum C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), total leucocyte count (TLC) and blood cultures were determined in sixty-six patients who were amongst the age group of one month to five years of age, who were diagnosed with WHO defined CAP.

Statistical Analysis: It was carried out by calculating the proportion, mean, standard deviation (SD) and the sensitivity of the test.

Results: The chest radiographs were found to be positive in 93.9% (n=62) patients, CRP was positive in 90.9% (n=60) patients, ESR was positive in 72.7% (n=42) patients, TLC was positive in 48.5% (n=38) patients and the blood cultures were positive in 6.1% (n=4) patients. Hence, the sensitivity of the chest radiograph, CRP, ESR, TLC and the blood culture in the diagnosis of CAP were 93.9%, 90.9%, 72.7%, 48.5% and 6.1%.

Conclusion: In view of the high sensitivity of CRP, which is almost similar to that of chest X-Ray in detecting CAP, CRP can be used as an alternative test to the chest radiographs at peripheral centres, where X-ray machines are not available.

Key words: Pneumonia, CRP, TLC, ESR, Blood culture, Chest radiograph

INTRODUCTION

Pneumonia is a major cause of morbidity and mortality worldwide, particularly among children in the developing countries, where half of the pneumonia related deaths occur within one year of age [1]. Pneumonia kills more children than any other disease and more than 2 million children die due to pneumonia each year, which accounts for almost one in five deaths under the age of five years worldwide. It is a critical disease for the countries to conquer, in order to reach the Millennium Development Goal 4: which aims at reducing the child mortality rate by two thirds from 1990 to 2015 [2]. Most of the children who die from pneumonia live in the developing countries, where the factors such as malnutrition, crowding, and lack of access to quality health care increase the risk for death.

Community Acquired Pneumonia (CAP) is defined as a Lower Respiratory Tract Infection (LRTI) which occurs in a child who has not been admitted to a hospital or a health care facility in the preceding 14 days [3]. The primary organisms which are responsible for pneumonia in the early age of up to three months are the group B *Streptococci* and the gram-negative bacilli [4]. Between three weeks and three months of age, the infants who may present with an insidious afebrile pneumonitis syndrome are infected by *Chlamydia trachomatis* [5]. Yet, overall, viruses are the common causes of pneumonia in the first five years of life, which account for up to 40–50% cases of pneumonia [6-8]. Amongst the causative viruses, the most common ones are the respiratory syncytial virus, followed by the parainfluenza virus types 1, 2, and 3, the influenza virus types A and B, adenoviruses and rhinoviruses and the less common ones are the herpes simplex virus and the enteroviruses [9]. As the age increases, the incidence of the pneumonia decreases, but the ailments which are caused by the bacterial pathogens viz *Streptococcus pneumonia, Mycoplasma pneumoniae, and Chlamydia pneumonia* become more frequent. In children, upto fifteen years of age, viruses are responsible for half of the pneumonia cases, whereas *Streptococcus pneumonia* accounts for 17% to 28% of all the community-acquired pneumonia cases [10], and *Mycoplasma pneumonia* which is the second most common agent after *Streptococcus pneumoniae,* is the most common pathogen in young adolescents, which has been identified in up to one-half of the cases [11].

The World Health Organization (WHO) [12] has defined a clinical criteria for making the diagnosis of pneumonia, which consists of the presence of cough which is associated with tachypnoea, fever (>38.5°C) and chest recession without wheeze. Tachypnoea is defined as a respiratory rate of over 40 breaths/min in children who are one to five years of age, of over 50 breaths/min in children who are two to twelve months old, and of over 60 breaths/min in children who are of the age of under two months.

This study was undertaken because; very less data is available on the comparison of the sensitivity of the chest radiographs and the laboratory parameters in rural setups. There is no alternative to the chest radiographs for making the diagnosis of CAP, especially at peripheral centres where X-ray machines are not available. Hence, this study was conducted with the following objectives: i) To check out the sensitivity of the laboratory parameters and the chest radiographs in the patients with WHO defined Community Acquired Pneumonia (CAP), ii) To compare the sensitivity of the C-Reactive Protein and the chest radiographs in the diagnosis of CAP and iii) To investigate the utility of the blood cultures in CAP.

MATERIAL AND METHODS

The Study Setting

This was a prospective study which was carried out over a period of two months (6th July 2011 to 6th September 2011) in the Department of Paediatrics of Dhiraj Hospital, which is a 1000 bedded multispecialty hospital which caters to the rural population of Vadodara and Waghodiya.

All the paediatric patients with clinically suspected pneumonia (as per the WHO criteria), who were admitted to the institute between 6th July 2011 to 6th September 2011, and were willing to participate in the study, were enrolled for the study. Before their enrolment, all the participants were explained about the nature and the purpose of

the study. Consents were obtained from their parents/ LARs (Legally Authorised Representatives). The concept of this prospective study, which was submitted under the title, 'correlation of clinically suspected community acquired pneumonia (CAP) with reference to the chest radiographs and the laboratory parameters in rural setups', was approved by the institutional ethics committee of the SBKS Medical Institute and Research Centre, on 6th July 2011.

The Study Subjects

A total of 66 patients who fulfilled the below mentioned criteria were enrolled in the study.

Inclusion Criteria

- All the patients of clinically suspected pneumonia as per the WHO criteria, who were amongst the age group of one month to five years of age.
- The patients who were willing to give informed consent.

Exclusion Criteria

- The patients who were not willing to give informed consent.
- Those who were suffering from critical or terminal illnesses, acute bronchial asthma exacerbation and chronic lung disease.
- Those who were already enrolled in the study.
- Known cases of pulmonary Koch's and who were receiving treatment for the same.
- The patients with immuno-compromised statuses
- The patients who were on antibiotics for more than 48 hours.

The demographic profile, complete histories, information on the vitals, respiratory system examinations and relevant systemic examinations of all the patients who were willing to participate in the study were recorded in a proforma and the patients were subjected to the following investigations – X-ray chest, PA view, complete blood count (CBC) with the use of a 'Sysmex KX21 Three Part Differential Automated Haematology Analyzer', blood cultures [13], ESR and the C-Reactive Protein (CRP) by the latex agglutination method [14] (the CRP Latex Kit was manufactured by Rapid Diagnostics, Pvt. Ltd.).

Interpretation of the Test Results

- **CXR:** The chest X-ray evaluation was carried out by an expert senior radiologist of our institute and he was kept blind about the clinical conditions of the patients.
- **ESR:** It was considered as positive when its value was above 20 mm/h. The normal range for the paediatric age group for both males and females considered was 0–13 [15].
- **CRP:** The presence of agglutination was considered to show positivity.
- **TLC:** A total leucocyte count of above 15,000/cu.mm. was considered as positive.
- **Blood Cultures:** Once the colonies were observed on the media, they were subjected to microscopy, gram staining and acid fast staining. The biochemical test for the specific soluble substance (SSS) for *S.pneumonia* was carried out and if no colony was observed, it was allowed to stay in incubation for 24 hours and was further observed. No growth even after this indicated that the blood culture was negative [16].

STATISTICAL ANALYSIS

It was carried out by calculating the proportion, mean, StandardDeviation (SD) and the sensitivity of the test.

OBSERVATION AND RESULTS

[Table/Fig-1,2 & 3].

Age (in months)	Male (%)	Female (%)	Over all
1–2	6 (9%)	2(3%)	8(12.1%)
2–12	16(24.2%)	10(15.2%)	26(39.4%)
12–60	16(24.3%)	16(24.3%)	32(48.5%)
Over all	38(57.6%)	28(42.4%)	66(100%)

[Table/Fig-1]: Age and sex distribution of study participants

The above data suggests that males were more commonly affected, as compared to females. CAP is more prevalent in the age group of one to five years of age.

Age (in months)	Mean RR (±SD)	Mean ESR (±SD)	Mean TLC (±SD)
1–2	68.5 (±4.1)	35.3 (±21.4)	15,525 (±129)
2–12	57.58 (±8.5)	36.5 (±20.8)	15,678 (±320)
12–60	46.7 (±10.9)	34.4 (±15.7)	15,166 (±105)
Over all	55.1(±12.6)	35.1 (±21.1)	15,559 (±112)

[Table/Fig-2]: Respiratory Rate (RR), ESR and TLC as per age of study participants

Age Group	Chest Radiograph	CRP	ESR>30	TLC>15000	Over all
1–2	75% (6)	100% (8)	75% (6)	0% (0)	8
2–12	92.3% (24)	92.3% (24)	92.3% (24)	69.2% (18)	26
12–60	100% (32)	87.5% (28)	68.7% (22)	43.7% (14)	32
Over all	93.9% (62)	90.9% (60)	72.7% (48)	48.5% (32)	66

[Table/Fig-3]: Sensitivity of various investigations according to age group of study population

The chest X-rays were found to be positive (which was manifested either as an isolated consolidation, a pleural effusion, infiltrates or a combination of these) in 93.9% of the study population. On the other hand, CRP was found to be positive in 90.9% of the cases, ESR of above 30 mm/h was found in 72.7% of the cases and a TLC of above 15,000/cu.mm. was found in 48.5% of the study participants.

DISCUSSION

The present study showed that the chest radiographs and the CRP positivity were strongly associated with the WHO defined community acquired pneumonia in all the age groups. ESR showed a moderate sensitivity, while the TLC and the blood cultures were not sensitive enough for the diagnosis of CAP. An association of raised CRP with the CAP was more in the younger age groups. The sensitivity of the chest radiographs, which was observed in this study was 93.9%, which was the same as those which was reported by Kiekara O et al., [17] in 1995 (96%); and by Stolz D et al., [18] in 2006 (96.7%). However, our results contradicted the results of the studies which were done by Patenaude et al., [19] 1995 (86%) and Bharti B et al., [20] in 2008 (83.1%). The sensitivity of the C-reactive protein, which was observed in our study was 90.9%, which matched with those of the studies which were done by Heiskanen-Kosma T et al., [21] in 2000 (94.3%), by Requejo HI et al., [22] in 2003 (98%) and by Enitan D and Carrol et al., [23] in 2009 (97.2%). Our results differed from those of the studies which were done by Massimiliano Don et al., [24] in 2009 (74%) and Virkki R et al., [25] in 2002 (73.5%).

The sensitivity of the Erythrocyte Sedimentation Rate which was observed in this study, when it was considered as positive above a reading of 30 mm/h was 72.7%, which was in line with the result of Massimiliano Don et al., [24] 2009 (72%). This result was in disagreement with the result of Virkki R et al., [25] 2002 (63.7%).

The sensitivity of the TLC in the study (when it was considered as positive above a level of 15,000/mm^3) was 48.5% which was similar to the result of the study which was done by Massimiliano Don et al.,

[24] in 2009 (49.3%). The result was not in support of the result of the study which was done by M.Korppi et al., [26] in 1997 (32.5%).

The sensitivity of the blood culture in this study was 6.1% which was similar to the results of Shah SS et al., [27] 2011 (2.1%) and Obaro SK et al., [28] 1996 (3.1%). So, it can be stated that the chest radiographs and the CRP have similarly high sensitivity for diagnosing CAP; ESR has a low fair sensitivity, but the TLC and the blood cultures have very low sensitivity.

All the patients with positive blood cultures were very severely sick as compared to others and they had high levels of TLC, ESR and CRP. So, these findings can help us in making a probable interpretation, that with increased sepsis, the chances of getting positive blood cultures increases in case of CAP. But in the routine cases, there is a very less chance of getting positive blood cultures and hence, the blood cultures can be excluded from the routine investigations.

On the other hand, the chest radiographs and CRP have higher sensitivity rates as compared to others and hence, there are higher chances of getting positive chest radiographs and CRP in case of pneumonia. Since, CRP and the chest radiographs have high and almost similar sensitivities, one can be replaced by the other.

CONCLUSION

In view of the high sensitivity of CRP, which is almost similar to that of chest X-ray in detecting CAP, CRP can be used as an alternative test to the chest radiographs at peripheral centres, where X-ray machines are not available. The TLC and ESR do not have high degrees of sensitivity in the diagnosis of CAP and hence, they should be used as adjuvants to the chest radiographs and CRP. Blood cultures have the lowest yield as compared to the other investigations and hence they can be excluded from the routine diagnostic investigation. As this was a small scale study, it may not add substantially, but it gives an insight for taking up larger studies.

Implications

CRP can be used as an alternative to the chest radiographs in the diagnosis of CAP at peripheral centres where X-Ray machines are not available.

LIMITATION

This was a small scale study and hence, similar large scale studies should be done at various centres of the country, to establish a cost effective, gold standard diagnostic criteria for CAP in the paediatric population.

ACKNOWLEDGEMENT

This was an ICMR (Indian Council Of Medical Research) funded research under STS-2011.

REFERENCES

[1] Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn JE, et al. Global, regional and national causes of child mortality: an updated systematic analysis of 2010 with time trends since 2000. *Lancet*. 2012;379: 2151-61. doi: 10.1016/S0140-6736(12)60560

[2] United Nations Development Programme. The Millennium Development Goals: eight goals for 2015 [cited 2012 Aug 8].http://www.undp.org/content/undp/en/home/mdgoverview.html.

[3] Bartlett JG, Dowell SF, Mandell LA, File Jr TM, Musher DM, Fine MJ. Practice guidelines for the management of community-acquired pneumonia in adults. *Clin Infect Dis.* 2000;31:347-82

[4] Adler-Shohet F, Lieberman JM. Bacterial pneumonia in children. *Sem Pediatr Infect Dis*. 1998;9:191-98.

[5] Jain R, Jain A, Agarwal J, Awasthi S. Chlamydia sp. in hospitalised children with community acquired pneumonia. *Indian Pediatr*. 2007 Mar;44(3):216-18.

[6] Mathisen M, Strand TA, Sharma BN, Chandyo RK, Valentiner-Branth P, Basnet S, et al. Clinical presentation and severity of viral community-acquired pneumonia in young Nepalese children. *Pediatr Infect Dis J*. 2010 Jan;29(1):e1-6. doi: 10.1097/INF.0b013e3181c2a1b9.

[7] Nair H, Nokes DJ, Gessner BD, Dherani M, Madhi SA, Singleton RJ et.al Global burden of acute lower respiratory infections due to respiratory syncytial virus in young children: a systematic review and meta-analysis. *Lancet.* 2010 May 1;375(9725):1545-55. doi: 10.1016/S0140-6736(10)60206-1.

[8] Figueiredo LT. Viral pneumonia: epidemiological, clinical, pathophysiological and therapeutic aspects. *J Bras Pneumol*. 2009 Sep; 35(9):899-906.

[9] Henrickson KJ. Viral pneumonia in children. *Sem Pediatr Infect Dis* 1998;9:217-33.

[10] Honkinen M, Lahti E, Österback R, Ruuskanen O, Waris M. Viruses and bacteria in sputum samples of children with community-acquired pneumonia. *Clin Microbiol Infect*. 2012 Mar;18(3):300-7. doi: 10.1111/j.1469-0691.2011.03603.x. Epub 2011 Aug 18.

[11] Heiskanen-Kosma T, Korppi M, Jokinen C, et al. Etiology of childhood pneumonia: Serologic results of a prospective, population based study. *Pediatr Infect Dis J.* 1998;17:986-91.

[12] World Health Organization, Division of Child Health and Development. Integrated management of childhood illness. Geneva: World Health Organization, 1997.

[13] Murray PR, Witebsky FG. The clinician and the microbiology laboratory. In: Mandell GL, Bennett JE, Dolin R,eds. *Principles and Practice of Infectious Diseases*. 7th ed. Philadelphia, Pa: Elsevier Churchill Livingstone; 2009:chap 17.

[14] CRP. Lab Tests Online. http://labtestsonline.org/understanding/analytes/hscrp/tab/test#. Accessed Oct. 4, 2012.

[15] John F. Nicholson, Michael A. Pesce. Reference ranges for laboratory test and procedures. In Nelson Text Book of Paediatrics, 17th edition. Saunder's Elsievier Publishers, 2004;2399.

[16] R. Ananthanarayan, C.K. Jayaram Paniker. Blood Culture. In Textbook Of Microbiology, 8th edition. University Press Publisher, 2009;295-96.

[17] Kiekara O, Korppi M, Tanska S, Soima Kallio. Radiological diagnosis of pneumonia in children. *Ann Med* 1996;28:69-72.

[18] Stolz D, Christ Crain M, Gencay MM, Bingisser R, Huber PR, Muller P Diagnostic value of signs, symptoms and laboratory values in lower respiratory tract infection. *Swiss Med Wkly*. 2006;136:434-40.

[19] Patenaude Y, Blais C, Ledu CP reviewed eighty three children with CAP. Reliability of frontal chest X-ray in diagnosing pulmonary opacities in children. *Invest Radiol.* 1995;30:44-48.

[20] Bharti B, Kaur L, Bharti S. Role of chest X-ray in predicting outcome of acute severe pneumonia. *Indian Paediatr. J*. 2008;45:889-90.

[21] Heiskanen-Kosma T, Korppi M. Serum C-reactive protein cannot differentiate bacterial and viral etiology of community-acquired pneumonia in children in primary healthcare settings. *Scand J Infect disease.* 2000;32:399-402.

[22] Requejo HI, Cocoza AM. C-Reactive protein in the diagnosis of community-acquired pneumonia. *Braz J Infect Dis J.* 2003;22:963-8.

[23] Carrol ED, Limangeni AM, Graham J. The diagnostic and prognostic accuracy of five markers of serious bacterial infection in Malawian children with signs of severe infection. *Plos one.* 2009;8:662-67.

[24] Massimiliano Don, Francesca V, Matti Korppi, M Canciani Differentiation of bacterial and viral community-acquired pneumonia in children. *Paediatrics International.* 2009;51:91-96.

[25] Virkki R, Juven T, Rikalainene H. Differentiation of bacterial and viral pneumonia in children. *Thorax.* 2002; 57:438-41.

[26] M. Korppi, T. Heiskanen-Kosma, M. Leionen. White blood cells, C-reactive protein and erythrocyte sedimentation rate in pneumo-coccal pneumonia in children. *Eur. Respir J.* 1997; 10:1125-29.

[27] Shah SS, Dugan MH, Bell LM, Grundmeier RW, Floris TA, Hines EM. Blood Culture in the emergency department evaluation of childhood pneumonia. *Paed Infect Dis J*. 2011;6:475-79.

[28] Obaro SK, Monteil MA, Henderson DC. The pneumococcal problem. *BMJ.* 1996;312:1521-55.

PARTICULARS OF CONTRIBUTORS:
1. 3rd year MBBS Student, S.B.K.S. Medical Institute & Research Centre.
2. Associate Professor, Department of Paediatricts, S.B.K.S. Medical Institute & Research Centre.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Mr. Dhairya Lakhani,
130 - NRI Hostel, Sumandeep Vidyapeeth University, At & Po Pipariya,Vadodara – 391760, India.
Phone: +919099969191, E-mail: dhairyalakhani@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Sep 30, 2012**
Date of Peer Review: **Jan 28, 2013**
Date of Acceptance: **May 27, 2013**
Date of Publishing: **Aug 01, 2013**