ORIGINAL ARTICLE

Effectiveness of Integrated Management of Neonatal Childhood Illness (IMNCI) Tool in Chest X-Ray Positive Pneumonia Cases among Children Ages 2 Months to 5 Years A Cross-Sectional Study

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ABSTRACT

IMNCI tool has widely been applied in many countries for screening, clinical diagnosis, and as a management tool for many common diseases, including cases of pneumonia. This study determines the effectiveness of IMNCI tools in the diagnosis of pneumonia as that of diagnosing pneumonia by gold standard method of X-ray Chest PA view besides finding out the sustainability in using the IMNCI guided antibiotics in managing cases of pneumonia from first care to the tertiary care facilities.

Methodology: We conducted a prospective, cross-sectional study among children with World Health Organization (WHO) Integrated Management of Childhood Illness (IMCI) chest-indrawing pneumonia at a tertiary care hospital in Pakistan and assessed CXR examinations. The primary endpoint was interrater reliability between CXR for pneumonia diagnosis among children with WHO IMCI chest-indrawing pneumonia.

Results: The study was done among 165 children aged between 2 months to 59 months who have visited Fatima Hospital, Baqai Medical University, due to their medical condition of cough OR fast breathing. Most of the mothers had been taking antibiotics for their sick children before they reached our set up and very few of them (15%) were found adherent to taking IMCI guided IMCI-guided antibiotic Amoxicillin, whereas the rest of all a huge majority of the cases were found using non-IMCI guided antibiotics constituting 85%, means other than oral Amoxicillin. A Sensitivity of 68.75% and a Specificity of 92.3% were found to IMCI tools validity in diagnosing pneumonia against X-ray chest positivity.

Conclusion: This study concludes that the accuracy of IMCI tools in recognizing childhood pneumonia was good rather than the diagnosis as that to the positive findings in Xray Chest findings. However, with good sensitivity and the best specificity with high PPV, it can be the best screening tool for the early detection of pneumonia among children<5 years and can achieve a better outcome with in-time recognition, appropriate care seeking, and early intervention avoiding irrational antibiotics.

Keywords: ARI: Acute Respiratory Infection, **AIDS:** Acquired Immunodeficiency Syndrome, **BMU:** Baqai Medical University, **IMCI:** Integrated Management of Childhood Illness, **IMNCI:** Integrated Management of Neonatal & Childhood Illness, **WHO:** World Health Organization, **UNICEF:** United Nations International Children's Education Funds, **MDG:** Millennium Development Goal, SDG: Sustainable Development Goal, **MNCH:** Maternal, Neonatal & Child Health Program.

INTRODUCTION

Over 120 million pneumonia cases occur annually resulting in an estimated one million deaths in children under five years of age [1,2]. Over 80% of pneumonia deaths occur at home [3]. Pakistan is among the top five countries that contribute to the majority of these pneumonia episodes and deaths globally [4].

In children, a non–fatal disease can progress within 2–3 days to a fatal outcome if appropriate care is not provided in time. Where access to health care is low, WHO and UNICEF recommend that trained community health workers (CHWs) treat pneumonia with oral antibiotics [5]. This requires the deployment of trained CHWs in the community, household recognition of pneumonia, and prompt care-seeking. Interventions promoting care seeking to improve mortality outcomes, but timely care seeking from an appropriate care provider is essential [5].

Recognition of a pneumonia episode by the caretakers is low in developing countries including Pakistan. Sometimes, they may recognize the symptoms, but delay care seeking [6]. Appropriate care seeking from health workers trained in standard pneumonia case management is low, particularly in rural and poorer communities [7]. A systematic review of studies from developing countries, including Pakistan found that care seeking from available CHWs for pneumonia was only 4.2% [8].

There may be concern about antibiotic misuse by CHWs in the community for treatment of pneumonia. However, it has been shown that trained CHWs using standard case management of pneumonia can reduce both pneumonia specific and infant mortality [9]. Moreover, standard case management of pneumonia at facility and community level improves rational use by reducing inappropriate antibiotic usage [10], potentially resulting in less pressure on antimicrobial resistance. However, in Asian countries majority of care seeking for suspected pneumonia is from private providers and one of the reasons for seeking care from private providers is the increased likelihood of receiving injections for pneumonia and antibiotics for diarrhea, which is perceived to be an appropriate treatment [8]. Irrational drug use by general physicians and occasionally by pediatricians has been reported from Pakistan as well [11].

In 1995, WHO and UNICEF developed Integrated Management of Childhood Illness (IMCI) as a premier strategy to promote health and provide preventive and curative services for children under five in countries with greater than 40 deaths per 1000 live births. In 2003 care for newborns under one week of age was added and the strategy was renamed as IMNCI in many countries. Over 100 countries have adopted IMNCI and implemented to varying degrees its three components: 1) improving health worker skills, 2) strengthening health systems and 3) improving family and community practices.

For the last 25 years IMNCI has been widely applied in screening [12–14], for clinical diagnosis and as management tool for many common diseases, including Pneumonias. Though many studies have been carried out in the past to validate this IMNCI tool, but so far little is known in regard with IMCI tools applied detected pneumonias to true positivity of pneumonia on X-ray

Chest findings and how much antibiotics are being used applying IMCI guidelines and irrationally at 1st referral, while not using this tool, and what is the protocol employed by the caregiver in giving antibiotics. Besides, this study will elaborate the number of Pneumonia cases applying IMNCI clinical tools positive at X-ray Chest findings for Pneumonias and are having irrational antibiotics applying IMNCI protocol.

MATERIALS AND METHODS

Study Setting: General Setting: Pakistan is the sixth most populous country (208 million) in the world [15], with 64% of its people living in rural areas [16]. Pakistan is currently experiencing a rapid population growth and, given the current rates, it will be the fifth most populous country globally by 2050. Pakistan currently ranks 26th in the world for under-5 child mortality rates [17]. The under-5 mortality rate (per 1000 live births) has reduced from 141 in 1990 to 89 in 2012, but is much slower than the goal of reducing it to 46 by 2015 [17]. Around half of all under-5 deaths occur in the first month of life (202,000/year). After these neonatal deaths, diarrhea, pneumonia, and malaria are the major causes of death of children under 5 worldwide [18], with clustering among low-birth weight or malnourished children. According to the Pakistan Demographic and Health Survey 2006–2007, the leading causes of death during the postnatal period are diarrhea (27%) and pneumonia (26%), and are closely associated with overlapping risk factors such as poverty, undernutrition, poor hygiene, and deprived home environment [15].

Specific setting: This study was undertaken at Fatima Hospital, Baqai Medical University Karachi. Fatima Hospital is a 500-bed teaching hospital attached to Baqai Medical University, located in Gadhap Town. It imparts both undergraduate as well as postgraduate teaching and training. The Department of Pediatrics comprises of 64 beds with 20 bedded Pediatrics Surgical Wards. Fatima Hospital mainly attracts patients from the Gadhap Town, which is the largest town of Karachi with 40 villages with estimated population of 1 million from different culture & Customs. As the said hospital is a charity setup, it also attracts patients from other low-income areas of Karachi, rural Sindh, lower Baluchistan, and Afghan refugees. Most patients belong to the low socio-economic group. This study was carried out to find the pattern of IMCI sensitization and case management of Pneumonia in Pediatrics unit at Fatima Hospital in the rural locality of Gadhap Town, Karachi.

Study Population: Children aged 2 months to 5 years of ages who are having Acute Respiratory Diseases visited Fatima Hospital were screened for Pneumonia applying IMCI Tools

Sample Size: Sample size was calculated based on the incidence of ARI [acute respiratory infection] in Pakistani =4% (Reference "Expanded program on immunization, GOP", Confidence Level 95%, "d" standard error of 10%, by considering the current COVID-10 situation. 165 children aged 2 months to 5 years having Acute Respiratory illness attended OPD, Emergency of Fatima Hospital and referral cases directly admitted in Pediatric Unit with their mothers/Caregivers and diagnosed with pneumonia were included in the study. While Children below 2 months and above 5 years of age and those with other than respiratory illness were excluded.

Data Collection Procedure: Written permission was sought from the Head of the Department Pediatric Unit and Medical Superintendent of Fatima Hospital for information and cooperation. A Semi-structured Questionnaire was developed and translated into Urdu language which was pretested before actual implementation. The House Officers and PGs at the Department of pediatrics were taken on-boarded and a preliminary explanation cum training was done by the prime Researcher before the data collection. The Head of the Radiology Department of Hospital was approached officially for the easiest accessibility of X-ray Chest and to write its interpretation.

All Children ages 2 months to 5 years having Acute Respiratory illness attending OPD, Emergency of Fatima Hospital and referral cases directly admitted in Pediatric Unit with their mothers/Caregivers and diagnosed with pneumonia were assessed according to the eligibility criteria of this study. Those who will fulfill the inclusion criteria, then written consent was taken from the parents or guardian to participate in the study. Then all consenting children were screened according to IMNCI guidelines and later were referred for Chest X-Ray. Mother/ caregiver were interviewed through semi structured questionnaire for rational antibiotic use and effectiveness for management of pneumonia cases by the health care providers. These interviews were conducted by all Hos & PGs who were trained prior to data collection, and they were responsible for screening and data collection.

The questionnaire contained the information about socio-demographic characteristics of the family, symptoms and duration of the Illness, signs & General Danger signs as per IMCI tools, type and duration of antibiotic used for the management of pneumonia. Besides, they were also asking for home remedies, self-treatment and antibiotics that are used by self or from preferred types care sought during child illness. The Questionnaires were handed over to Trained House Officers and PGs that have assigned in their respective place of duties at Pediatrics Department and they were questions the mothers with child having respiratory illness for last 05 days. Mother/caregiver were invited to participate in the interview after readily information & consent. In this way the necessary information was recorded in the questionnaires

Statistical Analysis: Data was entered and analyzed using the SPSS version 24. At the first stage of analysis, descriptive statistics were applied. At second stage, Accuracy of X-ray finding as compared to the revised IMCI guidelines were assessed using sensitivity, specificity, positive and negative predictive values, and area under the receiver operating characteristic curve (AUROC) values.

Ethical approval: The ethical approval was sought from Ethical Committee Baqai Medical University and permission to conduct research was obtained from the MS Fatima Hospital.

RESULTS

In this study, a total of one hundred and sixty (165) suspected cases of pneumonia were included. The mean age of the children was 2.09 ± 1.06. 123 (74.5%) of the children were having age between 1-2 years and 43 (25.5%) belonged to age group > 2-5 years. 77 (46.7%) were male and 88 (53.3%) were female. Majority of the patients were Sindhi speaking 62 (37.6%) followed by Pushto speaking 51 (30.9%), Baluchi (18.8%), Punjabi 13 (7.9%), Urdu 7 (4.2%) and only 1 (0.6%) belong to language other than above. Most of the mothers were illiterate 135 (81.8%), 7 (4.2%) had no formal education, 13 (7.9%) had primary schooling, 6 (3.6%) had high schooling and 4 (1.8%) had till college/university education. 160 (97%) of the mothers were housewife whereas, only 5 (3%) were working. Similarly, 104 (63%) of the fathers were illiterate, 8 (4.8%) had formal education, 28 (17%) had primary schooling, 15 (9.1%) had high schooling, 8 (4.8%) had education till college and 2 (1.2%) had till university. 3 (1.8%) were unemployed, 33 (20%) were employed, 112 (68%) were daily wages workers and 17 (10.3%) belonged to other occupations. 162 (98%) had between Rs. 20,000 -30,000, 1 (0.6%) had monthly income between Rs. 30,000-40,000 and 2 (1.2%) had monthly income > Rs. 40,000, demographics characteristics are given in table I.

Table 2 is related to the clinical features of the under-five suspected children of pneumonia, the mean duration of illness was 5.5+ 4.7 as most of the children 109 (66.1%) had duration of illness between 0-5 days. 42 (25.5%) had breath rate between 40 -50 breaths/min and 163 (74.5%) had between > 50-60 breath/minute. The most observed dangerous signs were unable to drink or breastfed 7 (4.2%) followed by convulsion current episode, vomiting everything and stridor in a calm child 6 (3.6%) each, unconscious or drowsy 5 (3%), and severe dehydration 3 (1.6%).

162 (98.2%) had cough with mean duration of cough was 5.5+ 4.7 days.

Figure 1 shows the X-ray findings, 89 (53.3%) of the children had no any findings, infiltrate found in 39 (23%) cases, hilar lymphadenopathy in 7 (4%), lobar Consolidation in 13 (8%), Bilateral consolidation 10 (6%), Interstitial Opacities in 3 (2%) and in 6 (3.60%).

Only 25 (15%) took IMNCI guided antibiotics and the rest of the patients 140 (85%) were given with non- IMNCI guided antibiotics. When stratified, among IMNCI guided antibiotics, only Amoxicillin was advised and among non-IMNCI guided antibiotics, most prescribed antibiotic was 3rd generation cephalosporin 50 (36%) followed by 2nd generation cephalosporin 42 (30%), Macrolides 27 (19%), Augmentin 11 (7.5%), Aminoglycosides 08 (6%) and Co-trimoxazole & 1st generation 02 (1.5%) as shown in figure 2.

Table 1: Demographics Characteristics of the Children (n =165)

Demographics	n (%)	Demographics	n (%)
Child Age (mean + SD)	2.09 ± 1.06	Mother's Occupation	
		• Housewife	160 (97%)
• 1-2 Years	123 (74.5%)	• Working women	05 (03%)
• >2-5 Years	43 (25.5%)		
Gender		Father's Education	
		• Illiterate	104 (63%)
		• No formal education	08 (4.8%)
• Male	77 (46.7%)	• Primary Schooling	28 (17%)
• Female	88 (53.3%)	• High Schooling	15 (9.1%)
		• College	08 (4.8%)
		• University	02 (1.2%)
Language		Father's Occupation	
• Urdu	7 (4.2%)	• Unemployed	3 (1.8%)
• Sindhi	62 (37.6%)	• Employed	33 (20%)
• Punjabi	13 (7.9%)	• Daily wages worker	112 (68%)
• Baluchi	31 (18.8%)	• Others	17 (10.3%)
• Pashto	51 (30.9%)		
• Others	1 (0.6%)		
Mother's Education		Monthly Income	
• Illiterate		• 20,000 – 30,000	162 (98%)
• No formal education	135 (81.8%)	• >30,000 – 40,000	01 (0.6%)
• Primary Schooling	07 (4.2%)	• >40,000	02 (1.2%)
• High Schooling	13 (7.9%)		
• College / University	06 (3.6%)		
	04 (1.8%)		

Table 2: Clinical Feature of Children Less Than Five Years Suspected with Pneumonia (n =165)

Clinical Feature	n(%)
Duration of child illness (days)	
• 0-5	109 (66.1%)
• 6-10	42 (25.5%)
• 11-15	11 (6.7%)
(Mean + SD)	5.5+ 4.7
Breath rate	
• 40-50	42 (25.5%)
• >50-60	163 (74.5%)
General Danger Signs	
• Convulsion current episode	6 (3.6%)
• Unable to drink or Breastfeed	7 (4.2%)
• Unconscious or drowsy	5 (3%)
• Vomiting everything	6 (3.6%)
• Stridor in a calm child	6 (3.6%)
Cough	
• Yes	162 (98.2%)
• No	03 (1.80%)
Duration of Cough (days)	5.5+ 4.7

Table 3 shows that out of 165 suspected patients of pneumonia, 112 (67.8%) were diagnosed with pneumonia. IMNCI truly diagnosed 77 (46.6%) of the pneumonia patients. The sensitivity and specificity of IMNCI for detection of pneumonia was

68.7% and 92.4% respectively while Positive and Negative predictive values were95% and 56.9% respectively. The diagnostic accuracy was 76.3%.
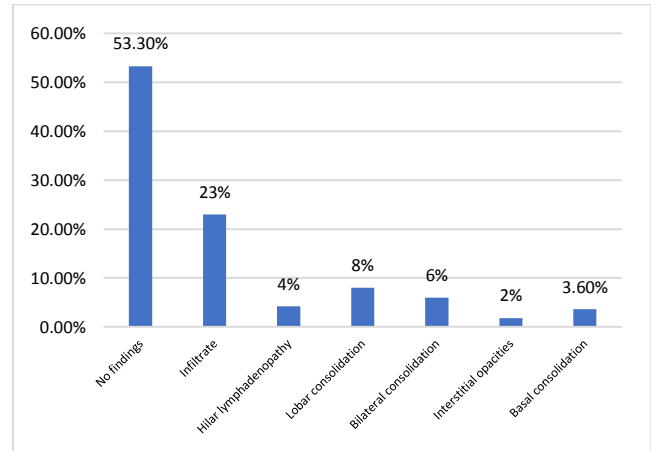

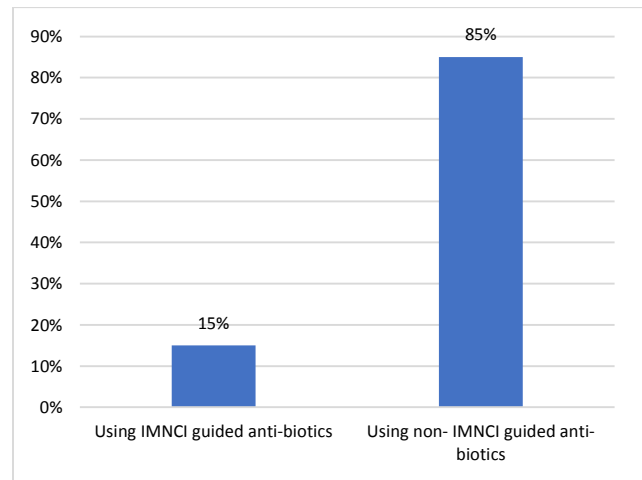Figure 1: Chest X-Ray Findings

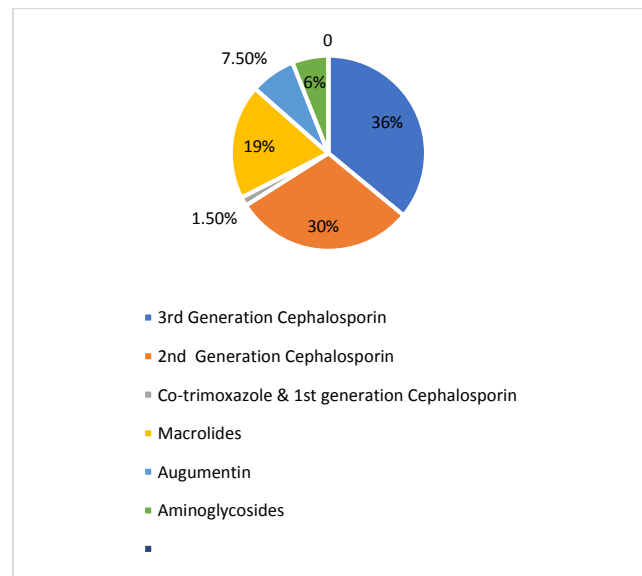

Figure 2: Use Ofimnci Guided Antibiotics

Figure 3: Type of Non-Imnci Guided Antibiotics Used

Table 3: Diagnostic Accuracy of IMNCI in Diagnosing Pneumonia by keeping Chest X-Ray as a Gold Standard (n=165)

IMNCI	Chest X-ray	
	Yes	No
Yes	(TP) 77	(FP) 4
No	(FN) 35	(TN) 49
Sensitivity	68.75%	
Specificity	92.4%	
PPV	95%	
NPV	56.9%	
DA	76.3%	

DISCUSSION

In our study, Mothers/Caregivers were assessed for recognizing their sick child whether they have dangerous signs during the current illness or not. Among the 165 children, all 16% of sick children mother were able to recognize their children's severity of illness which were, 3.6% had Convulsion in their current episode of illness, 3.6% were vomiting everything and stridor in a calm child each, 4.2% were unable to drink or breastfeed with looked unconscious or drowsy 3%, edema on both feet 2.4%, stiff neck and severe dehydration in 1.6% each. And all mothers/caregivers were able to recognize and have sought timely medical attention. However, most of the remaining mother/caregivers did not seek treatment from qualified practitioners. They first tried traditional remedies on their own at home. These findings in our study are consistent with a study that was conducted by Feikin DR and co-workers in [19].

A high rate of antibiotic prescription was observed in the cohort of mothers/caregivers in our study where most of the mothers had been taking antibiotics for their sick children before they reached at our set up and very few of them (15%) were found adherent to taking IMCI guided prescribed antibiotic Amoxicillin, whereas, rest of all a huge majority of the cases were found using non-IMCI guided antibiotics constituting 85%, means other than oral Amoxicillin. 3rd Generation Cephalosporin was the most prescribed (36%)non-IMCI antibiotic was found followed by the 2nd generation Cephalosporin which marked up to 30%.Whereas a few of the mother were found either bearing prescription or small bags containing the used bottles of non-IMCI antibiotics were Macrolides (19%), Synthetic Penicillin (Augmentin) 7.5%, and Aminoglycosides but with a very least percentage (1.5%) mothers were found using antibiotics co-trimoxazole and 1st generation Cephalosporin. These unguided irrationals using of antibiotics brings more morbidity in treating childhood Pneumonias besides increasing cases of resistance of antibiotics which have been proved in several studies besides a recent study which have done in Uganda by Christine Joy Abeja et al, aimed to determining the association between rational antibiotic prescription and in-patient treatment outcomes in children aged 2–59 months with pneumonia where they found that the majority of children had irrational antibiotic prescriptions and 40 percent of children aged 6–11 Months had unfavorable treatment outcomes with 20 percent death which is against Uganda clinical guideline for treatment of severe pneumonia among children under five [20, 21]. To safeguard antibiotics as a valuable resource, initiatives to promote rational antibiotic usage are crucial. Antibiotic use creates selective pressure that increases the prevalence of drug resistant strains. According to a study on antibiotic use in Vietnamese hospitals, many in-patients got ineffective antibiotic therapy [22]. Taking Vietnam as an example, the primary causes that encourage unwarranted antibiotic usage in the Western Pacific region.

In our study, all 165 selected cases of presumptive Pneumonia were undergone for the X-ray Chest PA view to determine whether all cases applying IMCI tools have any link to the true positivity to any of X-ray chest findings or not. 53% of the total cases of 165 were not having any findings in X-ray chest PA

view interpretation where rest of 47% were having positive findings in their chest x-ray with infiltration 23%, hilar lymphadenopathy, basal consolidation 3.6%, interstitial opacities 2%, bilateral consolidation and lobar consolidation were 6% & 8% respectively.

Diagnostic Accuracy of IMNCI in Diagnosing Pneumonia by keeping Chest X-Ray as a Gold Standard were interpreted for true & false positivity to IMCI guided tools detected pneumonia and Sensitivity & Specificity of the tools were determined as to the Xray chest PA findings. A Sensitivity of 68.75% and Specificity of 92.3% were found of IMCI tools validity in diagnosing pneumonia against X-ray chest positivity means all cases of IMCI tool detected Pneumonias are not always the true gold standard defined pneumonia, but a major percentage are of true standard pneumonia having one of any positive findings in X-ray Chest PA view. Presumptions on the fact of 92% specificity, we can undoubtedly declare based on high Positive Predictive Value of 95% in our study that IMCI tools is the best screening tools for childhood Pneumonias that can be taken in-time consideration for intervention in managing and treatment of all childhood pneumonias irrespective whether they are true positive pneumonia or not against Xray chest PA view which is justified as why no fatal outcomes has seen within the children our study framework.

The foremost objective of our study was to determine the sensitivity and specificity of IMNCI in diagnosing pneumonia by taking Chest X-ray as a gold standard. 67.8% consistency in assessing and classifying sick child in our study is better than that of study conducted in China which shows only 43.8% were correctly classified [23]. But the specificity of 92.4% in diagnosing the pneumonia cases (cough or difficult breathing complaint and a respiratory rate of 50 breaths or more per minute (2 months up to 12 months) or 40 breaths or more per minute (12 months up to 5 years recorded during re–examination) are not in line with a Brazilian study of 390 children, where Cardoso MRA et al investigated WHO criteria for defining pneumonia(cough or difficulties in breathing and tachypnoea) and found to have sensitivity of 94% for children less than 2 years of age and 62% for children ≥2 and specificities of 20% and 16% respectively. Adding fever improved specificity to 44% and 50% [24]. In Mexico, Palafox et al found that tachypnea, chest indrawing and crackles were the clinical signs that, alone or combined, showed a sensitivity of greater than 40% for identifying pneumonia. The combination of tachypnea and chest indrawing improved specificity upto 69% but sensitivity was 68% which is comparable to our study. Further combinations of crackles with tachypnea or chest indrawing or a combination of these three signs improved specificity to 80-84% but these three in combination yielded low sensitivity of 43-46% [25].

To our knowledge, this was the first study conducted on the diagnostic accuracy of clinical criteria of pneumonia in detection of radiological pneumonia in children who are 02m-05 years of age. We performed the study in a community setting with patients of various socioeconomic classes. Participants' compliance was high, and our radiologist was an expert in reporting X-rays Chest. Besides, the statistical analyses were straight-forward, and no missing data analysis was required. The key strength of the study is to have a relatively large no. of cases using an evidence-based sample size who were seen, managed, and treated with the same professional medical team.

A strict adherence to inclusion/exclusion criteria was observed during the study to control bias besides the clear operational definition of outcome variables. Most importantly, this is a prospective study so there is a lower risk of bias and missing data.

CONCLUSION

The conclusive remarks of the study are that the accuracy of IMCI tools in recognizing childhood pneumonia was relatively good rather than the diagnosis as that to the positive findings in Xray Chest findings. However, with good sensitivity and the best specificity with high PPV it can be the best screening tools for an

early detection of pneumonia among the U-5 children and can achieve a better outcome with an in-time intervention. But in contrary, non-adherence to IMCI guidelines to irrational uses of antibiotics are dis-appreciating and highly discouraging that eminently demands a National Guidelines of antibiotics uses among U-5 children for save the resistance of antibiotics in future in way to decrease not only the U-5morbidity & mortality but also out-of-pocket expenses of the caregivers.

Limitations:

• The literature on this topic is limited, and further research into identifying features that have diagnostic value is warranted.

• A single hospital-based study was conducted in a single catchment area of Karachi slums and mostly of nearer villages, so cannot be generalized.

• A non-probability successive sampling technique was utilized, which may prevent results from being generalized to the wider population.

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