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Cross-sectional Study

Assessment of the prevalence of congenital heart disease in children with pneumonia in tertiary care hospital: A cross-sectional study

Neeraj Kumar Jat, D.K. Bhagwani, Namita Bhutani *, Urvashi Sharma, Ram Sharma, Raju Gupta

North DMC Medical College and Hindu Rao Hospital, New Delhi, India

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ABSTRACT

Background and objectives: Pneumonia is the most common cause of death in children under five years of age. Epidemiological factors and the disease burden differ in developing and industrialized countries. The present study is a cross sectional observational study, carried out from August 2018 to August 2020 in Hindu Rao Hospital, to assess the prevalence of congenital heart disease (CHD) in patients with pneumonia in children up to 5 years. The main objectives of the study were to study the prevalence of congestive cardiac failure (CCF) in pneumonia with and without congenital heart disease.

Material and methods: Patients under 5 years of age, presenting with pneumonia during August 2018 to July 2020 were enrolled for study. The bio-data of each patient was documented each patient was clinically evaluated thoroughly and findings noted. Pneumonia was diagnosed on typical history, physical findings, blood investigations and chest radiographic finding of pneumonia infiltrates in either one or both lung fields. All the cases of pneumonia underwent transthoracic 2 Dimensional (2D) and Doppler echocardiography, done by the cardiologist. Any congenital heart disease so found was noted. The type and size of the defects was documented. The ventricular septal defects were classified based on the site and size. The size of the patient ductus arteriosus was also determined. These measurements were taken to evaluate the impact of defect size on pneumonia. CCF was diagnosed when the patient fulfilled the clinical diagnostic criteria of heart failure. All the cases of pneumonia underwent transthoracic 2 Dimensional (2D) and Doppler echocardiography for diagnosis of any congenital heart disease.

Results: Mean age of the children with pneumonia was 9.94 months with 77.5% of the cases below 1 year of age. Male predominance was seen with 56.3% males to 43.8% females. Prevalence of congenital heart disease among cases of pneumonia was 12.5% while that of congestive heart failure was 27.5%. Most common CHD observed was VSD (14 cases; 8.8%) followed by PDA, ASD and TGA (4; 2.5% and 3; 1.9% and 1; 0.6% cases respectively). A significant association was observed between presence of congenital heart disease and development of CCF.

Conclusion: Our study demonstrates that most patients with pneumonia or recurrent pneumonia are likely to have an underlying illness at the time of pneumonia. Recurrent ALRTI often occurred in children with history of congenital heart diseases (CHD) and is also associated with Congestive Cardiac Failure. Children with CHD are more vulnerable to recurrent respiratory tract infection.

1. Introduction

Acute Lower Respiratory Tract Infection (ALRTI) or Pneumonia is the most common cause of death in children under five years of age. Most cases of ALRTI in the world occurred in developing countries. Acute respiratory infections (ARI) result in 1.9 million childhood deaths per year in developing countries and 20% of these deaths are from India [1]. Epidemiological factors and the disease burden differ in developing and industrialized countries [2]. Several predisposing factors for Pneumonia have been identified, the major and common ones include disorders of immunity as seen in severe malnutrition, congenital and acquired immune deficiency states especially human immune-deficiency virus (HIV) [3].

Congenital heart disease (CHD) is defined as a gross structural abnormality of the heart or intra thoracic great vessels that is actually or potentially of functional significance. The incidence of congenital heart

* Corresponding author.
E-mail addresses: neerajkumarjat@gmail.com (N.K. Jat), drbhagwani@gmail.com (D.K. Bhagwani), namitabhutani89@gmail.com (N. Bhutani), urvashisharma@gmail.com (U. Sharma), rsharma@gmail.com (R. Sharma), drrajugupta@gmail.com (R. Gupta).

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disease (CHD) in the general population is about 1% and varies from 4/1000 to 50/1000 live births. In India the prevalence of congenital heart disease were found to be 2.25–5.2 per 1000 children. In congenital heart diseases (CHD) such as acyanotic CHD, because of a left to right shunting of blood, via a septal defect or the arterial duct, there is pulmonary over circulation and pulmonary oedema. The pulmonary oedema leads to congestive heart failure and becomes a nidus of infection for the lower respiratory tract infection. Ventricular septal defect (VSD), patent ductus arteriosus (PDA) and atrioventricular septal defect (AVSD) are common acyanotic CHD in childhood that predispose to bronchopneumonia. Others such as truncus arteriosus (TA) and total anomalous pulmonary venous return (TAPVR) are examples of cyanotic CHD predisposing the same [4].

Very few studies have been conducted to evaluate the prevalence of congenital heart disease in the initial episode of pneumonia [5,6]. Studies that identify features that predict underlying CHD in children with pneumonia at the very first pneumonia episode will thus be worthwhile. The present study was conducted with the primary aim to assess the prevalence of congenital heart disease (CHD) in patients with pneumonia in children up to 5 years and to study the prevalence of congestive cardiac failure (CCF) in pneumonia with and without congenital heart disease. In this study, children with pneumonia presenting at a tertiary health centre, underwent echocardiography to identify those with underlying CHD. Characteristics such as the presence of CCF (Congestive cardiac failure) and murmur were evaluated in children with pneumonia and CHD in comparison with pneumonia without CHD.

2. Material and Methods

The present Cross-sectional study was conducted in Departments of Pediatrics, Pathology and Cardiology, over a period of two years (2018–20) on children in the age group up to 5 years admitted in our Hospital. A total of 160 cases were included in the study after obtaining the Ethical clearance from the Institutional Review Board, vide no. 8597/HRH/2018 Dated 04/12/2018 (Certificate attached).

The inclusion Criteria of our study were, all cases of pneumonia who were less than 5 years of age with the symptoms of fever, cough, tachypnoea, as delineated by the WHO [20], 0–2 Months: - Breathing rate of 60 cycle per minute, 2–12 Months: Breathing rate of 50 cycles per minute, 12–59 Months: Breathing rate of 40 cycle per minute, dyspnoea and/or increase work of breathing, Intercostal, Subcostal, Suprasternal retraction with nasal flaring or use of accessory muscles of respiration; along with radiological confirmation of pneumonia. All the known cases of CHD, patients with pneumonia in CCF and all children with recurrent or persistent pneumonia were included in the study. While all the known cases of bronchial asthma, children more than 5 years of age and those who do not give consent for participation in the study or if the death occurs prior to getting the investigations done, were excluded from this study.

Patients under 5 years of age, presenting with pneumonia between August 2018 to July 2020 were enrolled for study. The bio-data of each patient was documented. This includes name, age, gender, height/length, weight and address. Each patient was clinically evaluated thoroughly and findings noted. Pneumonia was diagnosed on typical history, physical findings, blood investigations and chest radiographic finding of pneumonia infiltrates in either one or both lung fields. A chest radiograph was done for each patient as part of the routine investigation for pneumonia in the center. The radiograph was read by the radiologist. Pneumonia was confirmed when report was positive. CCF was diagnosed when the patient fulfill the clinical diagnostic criteria of heart failure [7].

All the cases of pneumonia underwent transthoracic 2 Dimensional (2D) and Doppler echocardiography, done by the cardiologist. Any congenital heart disease so found was noted. The type and size of the defects was documented. The ventricular septal defects were classified based on the site and size. The size of the patient ductus arteriosus was also determined. These measurements were taken to evaluate the impact of defect size on pneumonia. The type of the other CHD was determined and noted. Other parameters obtained for each patient were duration of admission and outcome. The resolution of pneumonia was decided on the basis of clinical findings such as stable breathing rate, disappearance of pulmonary crepitations and radiological findings. The information was obtained with the aid of a proforma. The Algorithm of Methodology is presented in Fig. 1.

The patients were managed as per the standard protocols. All children with a clear clinical diagnosis of pneumonia received antibiotics as bacterial and viral pneumonia cannot be reliably distinguished from each other. Amoxycillin was used as a first line empirical therapy. Macrolides antibiotics may be added at any age if there is no response to first-line empirical therapy or if mycoplasma or chlamydia pneumonia is suspected or in cases of very severe disease. After initial stabilisation & diagnosis of children with CHD patients are referred to higher centre for further opinion on cardiology & paediatric cardiac surgery. In the current study to assess further management of the patient, it was required to telephonically keep the patient in follow-up.

The quantitative data was represented as their mean ± SD. Categorical and nominal data was expressed in percentage. The *t*-test was used for analysing quantitative data, categorical data was analysed by using chi-square test. The significance threshold of p-value was set at <0.05. All analysis was carried out by using SPSS software version 21 (IBM, NY, Armonk, USA). The work has been reported in line with the STROCSS criteria [8].

3. Results

The current study was done to assess the prevalence of congenital heart disease in children with pneumonia at a tertiary care hospital in a sample size of 160 paediatric patients of <5 years age. A population of 230 paediatric cases were assessed from August 2018 to August 2020 out of which 160 patients were found eligible for inclusion. 70 cases were excluded based on the exclusion criteria. All 160 patients had undergone 2D Echo for detection of congenital heart defects after radiological confirmation of pneumonia. During their hospitalisation each patient was observed for any adverse effects.

The mean age of the children with pneumonia was 9.94 months with 77.5% of the cases below 1 year of age. Male predominance was seen with 56.3% males to 43.8% females. Most common symptoms of pneumonia were fever (100%) followed by difficulty in breathing (96.3%) and cold/cough (95%). Presence of tachypnoea was seen in all cases, crepitations were evident in 90.6% of the cases, while chest retraction was seen in 91.9% cases. However, cyanosis was seen in only 3.1% of the cases. On x-ray, interstitial pneumonia was seen in 58.1% of the cases, consolidation/opacity was seen in 35.0% cases, while linear and patchy densities were noted in 6.9% cases. Recurrent pneumonia was reported in 20.6% cases, while 7.5% had persistent pneumonia.

In the present study, out of 115 patients with first episode of pneumonia, 11 had CHD, while out of 11 cases of persistent pneumonia only one case had CHD. The association between CHD and occurrence of pneumonia episodes was statistically insignificant (chi-square test, p-value is 0.072214). Prevalence of congenital heart disease among cases of pneumonia was 12.5% while that of congestive heart failure was 27.5%. Both CHD and CCF were seen in 10% cases. Out of the 20 cases of CHD, 11 cases (55%) were diagnosed on the initial episode of pneumonia.

For Congestive cardiac failure features, the most common symptoms were respiratory distress (84%), heap tomegaly (81%), feeding difficulty (79.4%), diaphoresis (50%) and poor weight gain (3.2%). The association between CCF and pneumonia episodes in patients with CHD was studied. Out of 11 patients with first episode of pneumonia 9 had CCF, while out of 8 cases of recurrent pneumonia 6 cases had CCF. The association between CCF and occurrence of pneumonia episodes in CHD

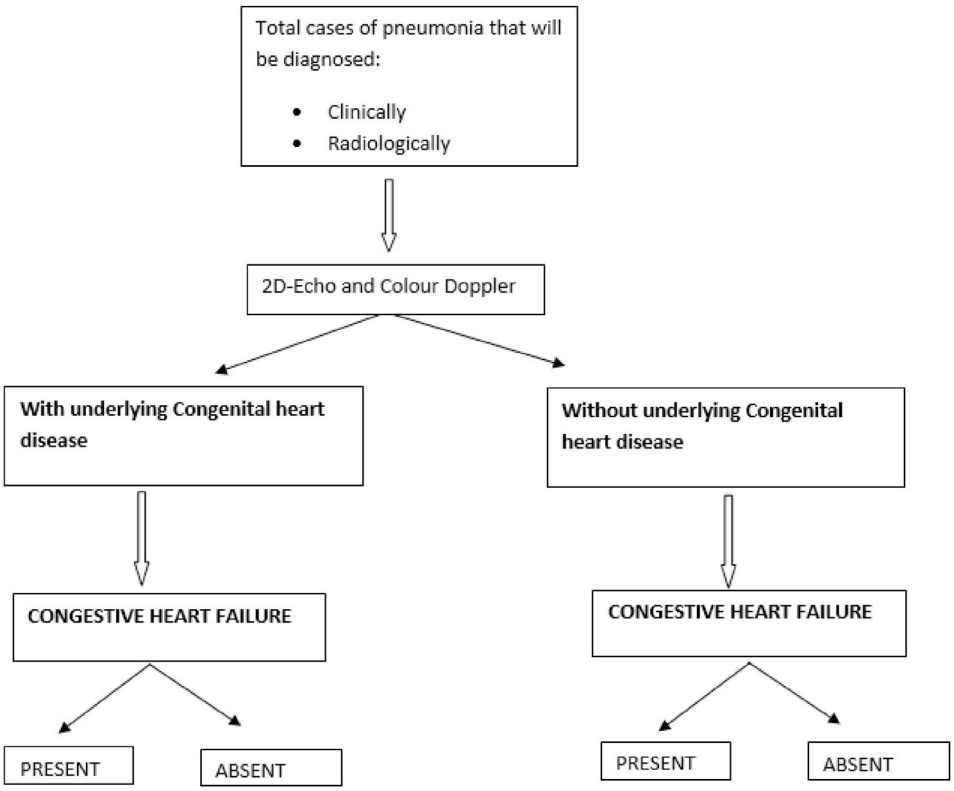

Fig. 1. Algorithm of methodology.

patients was statistically insignificant (chi-square test, p-value is 0.620473).

Hyperactive precordium (90%) and murmurs (85%) were most common CHD findings followed by cardiomegaly (50%) and increased broncho-vascular markings (35%) in pneumonia with CHD cases. Most common CHD observed on echocardiography was VSD (14 cases; 8.8%) followed by PDA, ASD and TGA (4; 2.5% and 3; 1.9% and 1; 0.6% cases respectively). Mild, moderate and severe VSD was seen in 1.9%, 5.6% and 1.3% cases each respectively. Most common type of congenital heart disease in our study was isolated VSD (7.5%) followed by PDA (2.5%). A total of 2 (1.3%) cases had ASD and 1 (0.6%) case had ASD and VSD both. TGA was evident in only 0.6% of the cases. Associated co-morbidities in isolated CCF cases were severe anemia (71.4%), severe acute malnutrition (17.9%), nephrotic syndrome and liver disease (3.6%) each. No co-morbidity was seen in 21.4% cases.

In our study, out of 140 cases of pneumonia without CHD 28 had CCF, while out of 20 cases of pneumonia with CHD, 16 had CCF. Association between CHD and CCF in pneumonia cases was statistically significant. (p-value <0.05). The number of cases with CCF was significantly higher in patient with CHD (Table 1).

Most common type of CHD associated with development of CCF was isolated PDA (100% cases), TGA (100%) and VSD (91.7%). ASD was not associated with development of CCF in pneumonia cases.

In cases of pneumonia with CHD the need for oxygen therapy, diuretics, inotropes and ventilatory support was 85%, 80%, 40% and 20% respectively whereas in cases of pneumonia without CHD the need for oxygen therapy, diuretics, inotropes and ventilatory support was 38.5%, 19.2%, 9.2% and 6.4% respectively. In pneumonia with CHD the mean hospital stay was more than 7 days in 95% cases while in pneumonia without CHD cases it was less than 7 days in 75.7%. Mortality was observed in pneumonia with CHD cases and pneumonia without CHD cases 10% and 3.57% respectively. Outcome was significantly better in patient of Pneumonia without CHD as compared to patients of pneumonia with CHD (chi-square test, p-value < 0.00001).

On follow-up, out of 20 pneumonia with CHD patients 12(60%) were on medication, 4(20%) were operated for CHD, 3(15%) were lost to follow-up and 1(5%) was expired.

Table 1
Association between CHD and CCF in Pneumonia cases.

Pneumonia	CCF		Total
	Present	Absent	
With CHD	16	4	20
Without CHD	28	112	140
Total	44	116	160

Chi-square test p value < 0.05.

4. Discussion

Congenital heart disease was the underlying cause of an estimated 261247 deaths globally in 2017, a 34·5% decline from 1990, when the number of deaths was 398580. Of all congenital heart disease deaths in 2017, 69% occurred in infants younger than 1 year. Conditions closely related to congenital heart disease, lower respiratory infections (i.e., pneumonia), is the leading cause of death in children globally. Infants with hemodynamically significant CHD have a major risk of ARI, frequent pneumonia (70% of cases). The association of severity of ARI, specific infections and CHD requires multidisciplinary approach to prevent major cardiac and respiratory complications. So, the present study was conducted on children with pneumonia presenting at a tertiary health centre, to identify the underlying CHD. Characteristics such as the presence of CCF (Congestive cardiac failure) and murmur were evaluated in children with pneumonia and CHD in comparison with pneumonia CHD.

In present study, mean age of the children with pneumonia was 9.94 months with 77.5% of the cases below 1 year of age. Sadoh WE et al. reported the mean age at presentation with pneumonia of the patients with various CHD was 8.57 ± 8.77 months, with 51% males [9].

Similarly, Meshram RM et al. reported 56.28% of patients in their study were below 1 year of age including 20.47% of neonates [10]. Gender distribution was 56.98% of males with a male: female ratio of 1.3:1. Similar type of distribution and gender prevalence has also been reported by Mahapatra A et al. [11].

Fever, tachypnoea, nasal flaring (in infants), and reduced oxygen saturation are highly predictive of pneumonia [12]. In our study, clinical features at presentation were, fever (100%), difficulty in breathing (96.3%) and cold/cough (95%). Tachypnoea were seen in all cases, crepitations or decreased air entry was present in 90.6% while chest retraction was seen in 91.9% cases. On x-ray, interstitial pneumonia was seen in 58.1% cases, consolidation/opacity was seen in 35.0% cases while linear and patchy densities were noted in 6.9% cases. Whereas all the patients with CCF reported with respiratory distress (84%), hepatomegaly (81%), feeding difficulty (79.4%), diaphoresis (50%) and poor weight gain (3.2%). Similar clinical presentations have been observed by other studies, Lynch and colleagues also identified fever, decreased breath sounds, crackles, and tachypnoea as independent predictors of pneumonia in a group of 570 children one to 16 years of age presenting to the emergency department (ED). Findings of fever and decreased breath sounds, crackles, and tachypnoea had excellent sensitivity as predictor of pneumonia. X-ray findings showed consolidation [13]. Gabriela K et al. also reported that almost all children who came to the hospital were complaining about breathing difficulty (98%), cough (75.2%), fever (85.2%), and runny nose (63.1%). These are common signs and symptoms of ALRTI. Tachypnoea (87.2%) and tachycardia (75.2%) were the most common signs found for vital abnormality. Most of the children (89%) had chest retraction, chest x-ray showed infiltrate (80.5%) and increase of broncho-vascular pattern (75.8%) were the common findings in children with ALRTI [6].

Tachypnoea was symptoms of respiratory disturbance which has high both sensitivity and specificity in diagnosing pneumonia. Crepts (wet rhonchi) was specific additional breath sound found in children with pneumonia in other studies, which was also observed in the present study [14,15]. Recurrent pneumonia was reported by 20.6% cases while 7.5% had persistent pneumonia in the present study. Children with CHD are at risk for increased morbidity from viral lower respiratory tract infections because of anatomical cardiac lesions than can worsen an already compromised respiratory status and leads to recurrent infections [16]. Recurrence of pneumonia has a very strong correlation with some underlying pathology, study by Owayed AF et al. demonstrates that most patients with recurrent pneumonia are known to have an underlying illness at the time of pneumonia recurrence, where they reported congenital cardiac defects (9%) as one of the important underlying cause [3].

Available Indian studies had reported a wide variation in the general prevalence of CHD which varies from 2.25 to 26 per 1000 live births with state wise variation [17–19]. A systemic review also reported a higher prevalence in Asia due to high birth rate and consanguinity, especially in Iran and India [20].

CHDs are also one of the major causes of infant mortality. In 90% of the CHD cases, there is no identifiable cause that can be attributed as multifactorial defects, and the most cases are asymptomatic and discovered during routine neonatal check-ups [21]. Children with CHD are at risk for increased morbidity from viral lower respiratory tract infections because of anatomical cardiac lesions than can worsen an already compromised respiratory status [17].

In the present study prevalence of congenital heart disease in pneumonia was found to be 12.5% of which 95% were acyanotic whereas 5% were cyanotic, when compared to the frequency of occurring pneumonia in the first episode, recurrent episodes and persistent it was found to be 9.57%, 24.24% & 8.33% respectively. Amongst CHD the commonest were VSD (60%), PDA (20%), ASD (10%) and TGA (5%). In a similar study conducted by Sadoh et al. the prevalence of CHD was 14 (11.57%) of which the commonest CHD was VSD in 7(50%). Most of the CHD with septal defects had moderate to large defects [9]. Another study conducted by Owayed et al. in children with recurrent pneumonia found an underlying illness of which congenital heart defects contributed 9% (22 cases of 238) which was lower than current study [3]. Ciftci et al. [22] retrospectively evaluated children with recurrent pneumonia and found the prevalence of CHD to be 9% (of 71 cases) which again is lower than current study.

Cebezuelo et al. conducted a retrospective study to evaluate causes in recurrent pneumonia patients [23]. Out of 106 recurrent pneumonia cases underlying cause such as congenital cardiac defects in 27 patients accounting to (29.3%) which was slightly higher than current study. Singh PK et al. aimed to assess CHD in patients presenting with recurrent lower respiratory tract infection (LRTI) [24]. Of the 100 patients, 43 patients (43%) with recurrent LRTI were found to have CHD (6.9% were cyanotic) which was higher than the current study and the commonest CHD was VSD in 39.5% followed by ASD 25.5% and PDA 16.5% Bolursaz MR et al. conducted a study on underlying causes of persistent and recurrent pneumonia in children and found out that 128 patients of recurrent pneumonia, 23 (17.9%) were having underlying congenital heart disease. And out of 101 patients of persistent pneumonia, 5 (4.9%) were having congenital heart disease [25]. Both categories were lower than current study.

Pejaver R et al. assessed the incidence of CHD in patients a total of 100 with recurrent LRTI revealing CHD is a major cause for recurrent LRTI which accounted to 41% of cases out of the total of which 92.7% were acyanotic and 7.3% were cyanotic. Amongst which, VSD were the most common (42.1%) followed by ASD (31.5%) and PDA (15.7%) which was similar to current study [26]. Total prevalence as compared to the current study was higher. Gabriela K et al. conducted hospital-based retrospective study out of the total study population of 3, 897 children who had ALRTI, there were 149 children with CHD (3.8%), lower as compared to the present study [6]. Commonest CHD was PDA 47.6% followed by VSD 47% and ASD 18.1% Various other studies conducted on Congenital heart diseases have reported that VSD is the most common CHD while TOF was the most common cyanotic CHD. Most of the studies in the literature reported similar observation from India and other countries; however, few studies reported a higher incidence of PDA compared to ASD [19–21,27–29] which is in accordance to the findings of the present study.

We also observed in our study that 9.5% of the initial episode of pneumonia cases were diagnosed with CHD, most previous reports identified CHD as an underlying cause of recurrent pneumonia [3]. To the best of our knowledge, we did not come across literature to support this finding. The findings of our study were compared with our studies. The same has been mentioned in Table 2, which shows prevalence of CHD in Pneumonia of various studies.

Studies in adult patients revealed that the presence of a cardiac event, such as congestive heart failure (CHF), is among the leading complications that increase the chances of morbidity and mortality [30,31]. However, the association in paediatric patients is not well established. Present study also tried to explore the characteristics and factors associated with the presence of CHF in under-5 children reporting with pneumonia and found the prevalence of congestive heart failure (CCF) was 27.5%. Both CHD and CCF were seen in 10% cases. Few studies that have been conducted on the present matter have reported different prevalence of the disease, one study conducted in the paediatric wards of a tertiary hospital in Nigeria by Sadoh WE et al. reported 64% of patients with congestive cardiac failure had pneumonia with underlying CHD and 37% of patients with pneumonia without any underlying illness [9]. A prospective study by IltenF et al. found an incidence of 14% among 50 children with pneumonia, this variation in results can be attributed to geographical variation [32].

A systematic review in adults conducted by Corrales-Medina VF et al. has reported the incidence of CCF in Respiratory infections to be (14%, range 7–33%) [33]. Clinical features suggestive of HF in infants include tachypnea, feeding difficulty, diaphoresis, etc. Feeding difficulty ranges from prolonged feeding time (>20 min) with decreased volume intake to

Table 2
Comparison table of prevalence of CHD in Pneumonia of various studies.

S. No	Authors	Year of study	Study population (Type of pneumonia)	Age group	Sample size	Prevalence of CHD (%)	Remarks
1	Owayed et al.	2000	Recurrent pneumonia	<12 years	238	9	Study population showed 9% prevalence of CHD which is lower than current study
2	Ciftci et al.	2002	Recurrent pneumonia	<12 years	71	9	Study population showed 9% prevalence of CHD which is lower than current study
3	Ozdemir et al.	2004	Recurrent pneumonia	<16 years	62	11.3	Study population showed 11.3% prevalence of CHD which is lower than current study
4	Cebezuelo et al.	2005	Recurrent pneumonia	<14 years	106	29.3	Study population showed statistically **significant** 29.3% prevalence of CHD which is higher than current study
5	Kumar M et al.	2007	Persistent pneumonia	<13 years	41	4.8	Study population showed 4.8% prevalence of CHD which is lower than current study
6	Sadoh et al.	2012	First episode pneumonia	<16 years	121	11.57	Study population showed statistically **significant** 11.57% prevalence of CHD which is higher than current study
7	Bolursaz et al.	2013	1. Recurrent 2. Persistent	<18 years	128 101	18 4.5	Study population showed 18% and 4.5% prevalence of CHD which is lower than current study
8	Saad et al.	2014	Persistent pneumonia	<18 years	27	14.8	Study population showed 14.8% prevalence of CHD in persistent pneumonia which is higher than current study
9	Harish et al.	2016	Recurrent pneumonia	<5 years	40	10	Study population showed 10% prevalence of CHD which is lower than current study
10	Singh PK et al.	2017	Recurrent pneumonia	<12 years	100	46.5	Study population showed Statistically **significant** 46.5% prevalence of CHD which is higher than current study
11	**Present study**	2018–2021	1. First episode 2. Recurrent 3. Persistent	<5 years	115 33 12	9.56 24.2 8.3	Current study showed Statistically **significant** prevalence of CHD in first & recurrent episode of pneumonia

frank intolerance and vomiting after feeds. Irritability with feeding, sweating, and even refusal of feeds are also common. Established HF presents with poor weight gain and in the longer term, failure in linear growth can also result. Oedema of face and limbs is very uncommon in infants and young children. Tachycardia, respiratory rate, gallop rhythm, and hepatomegaly are also the features of HF in infants [34].

Cardiomegaly on paediatric CXR is suggested by a cardiothoracic ratio of >60% in neonates and >55% in older children. Cardiomegaly is highly predictive of ventricular dilation on echocardiography, with high specificity. In present study, most common features of patients who had CCF were respiratory distress (84%), hepatomegaly (81%), feeding difficulty (79.4%), diaphoresis (50%) and poor weight gain (3.2%). Hyperactive precordium (90%) and murmurs (85%) were most common CHD findings followed by cardiomegaly (50%) and increased broncho vascular markings (35%). Gabriela K et al. reported systolic murmurs (63.7%), cardiomegaly (61.7%), increased broncho vascular markings (75.8%) as a characteristic finding in ALRTI children with CHD [6]. Sadoh WE et al. from Nigeria in a similar study also reported Cardiomegaly cardiothoracic ratio (CTR) > 60%, dilated ventricular chambers, myocarditis, CCF were pointers to CHD complicating pneumonia [9]. Similar clinical presentation has also been reported by Memon Y et al. they reported infant feeding difficulties, excessive sweating restlessness, tachycardia, tachypnoea and failure to thrive are the usual clinical feature [35]. While in toddler and older children fatigue, exercise intolerance tachycardia, tachypnoea, poor appetite, wheezing, gallop rhythm, hepatomegaly, peripheral oedema, murmur and growth failure are the features.

Associated co-morbidities in isolated CCF cases in present study were anaemia (71.4%), severe acute malnutrition (17.9%), nephrotic syndrome and liver disease (3.6%). Nutritional disturbances always affect immune system, therefore it increases the risk of infection and slowing down the healing process. Study by Caulfield et al., in 2004 showed that 52.3% of death due to ALRTI was associated with malnutrition [36]. In the study generated by Nataprawira et al., showed that malnutrition was one of risk factors for morbidity and mortality of severe pneumonia on children under age of 5 [37]. Malnutrition associated with Failure to Thrive (FTT). In this study, FTT was found in 12.8% children. Shah et al. reported FTT was found in 11.9% children with CHD and cardiac associations [27]. The FTT is a major symptom of CHD because of low energy expenditure, inadequate food intake, and malabsorption or feeding difficulties.

Anaemia plays a unique role, considering the similarities in symptoms and the importance of oxygen carrying capacity in the manifestation of heart failure. Anaemia is common among adult heart failure patients and is associated with adverse outcomes, present study observed high prevalence of Anaemia in CCF patients, Goldberg JF et al. conducted a review of the medical records of 172 hospitalisations for acute heart failure and reported that anaemia was found to be in 38% of the patients [38]. While one study Mueller GC et al. 64% of patients with congestive heart failure had or developed anaemia, they also reported renal impairment in about 66% of heart failure patients, which may partly contribute to the lower than expected increase of erythropoietin in response to hypoxemia and decreased perfusion [39]. The potential mechanisms linking anaemia to CHF have not been characterised, but may be related to changes in ventricular loading conditions. Growth failure has also been seen to the most common complication in patients followed by congestive cardiac failure and pneumonia. A study done by Harshangi et al. reported growth retardation in 56% of the patients with CCF in their study [40].

A significant association was observed between presence of congenital heart disease and development of CCF in the present study. Out of total 20 cases with congenital heart disease, heart failure developed in 16 cases (80%) as compared to 28 cases (20%) without CHD. Most common type of CHD associated with development of CCF in the present study was isolated PDA (100% cases), TGA (100%) and VSD (91.7%). Sadoh et al. studied of the 14 patients with CHD, more patients 9 (64.29%) had their pneumonia complicated by congestive cardiac failure while of the 107 children without CHD, 40 (37.38%) had pneumonia and congestive heart failure the difference was not statistically significant $p = 0.084$ whereas in the present study the difference was found to be statistically significant $p < 0.01$ [9]. The findings of our study were compared with our studies. The same has been mentioned in Table 3, which shows prevalence of CCF in CHD and Pneumonia groups of various studies.

Congenital heart defects have been reported to be the most common cause of cardiac failure in children [41]. Similar results have been reported by Krithiga Murugesan et al. they reported the commonest aetiology of CCF is congenital heart disease and the commonest lesion is VSD, present study differed slightly in regard to type of CHD but VSD was the commonest CHD present in our study and high number developed CCF [42]. Present study observed 100% CCF development in cases of PDA and TA, truncus arteriosus (TA) and total anomalous pulmonary

Table 3
Comparison table of prevalence of CCF in CHD and Pneumonia groups of various studies.

S. No.	Authors	Year of study	Study population	Age group	Sample size	Prevalence of CCF (%)	Remarks
1.	Meberg et al.	1996	CHD cases	2wks-11 years	84	8	Study population showed 8% prevalence of CCF in CHD cases
2.	Miyake et al.	1996	VSD cases	1–88 days	225	46	Study population showed Statistically **significant** 46% prevalence of CCF in VSD cases
3.	Najm et al.	1996	ASD cases	16 years	180	20	Study population showed 46.5% prevalence of CCF in ASD cases
4.	YltenF et al.	2003	Pneumonia cases	24 months	50	14	Study population showed 14% prevalence of CCF which is lower than current study
5.	Azhari et al.	2003	ASD cases	1–11 years	121	11.6	Study population showed 11.6% prevalence of CCF
6	Shah et al.	2006	CHD cases	<15 years	84	54	Study population showed Statistically **significant** 54% prevalence of CCF in pneumonia cases
7.	Hong et al.	2010	TGA cases	1–108 days	28	17.9	Study population showed 17.9% prevalence of CCF.
8.	Sadoh et al.	2012	1. Pneumonia with CHD	<48 months	14	64	Study population showed 64% & 37% prevalence of CCF which is lower & higher respectively than current study.
			2. Pneumonia without CHD		107	37	
9.	Nimdet K et al.	2017	Pneumonia	<5 years	135	10	Study population showed 10% prevalence of CCF which is lower than current study.
10.	Present study	2018–2021	1. Pneumonia with CHD	<5 years	20	80	Current study showed Statistically **significant**
			2. Pneumonia without CHD		140	20	prevalence of CCF (p-value <0.01).

Note: In view of lack of recent literature about prevalence of CCF in Pneumonia with CHD we have provided references older and/or before year 2000.

venous return (TAPVR) are examples of cyanotic CHD. The patients with CHD with increased pulmonary blood flow thus presents with pneumonia and congestive cardiac failure (CCF) [43,44].

In current study 20% cases of pneumonia with CHD were required mechanical ventilation whereas 3.57% of pneumonia without CHD, mortality reported was 5% in cases of pneumonia with CHD & 2.1% in cases of pneumonia without CHD. In another study conducted by Shim WS et al. out of 76 children with RSV infection 45 were CHD and 31 were non-CHD patients [45]. Of total 71 patients, 22(48.9%) were treated in intensive care in 3 of non-CHD patients (9.7%), 12 (26.7%) were required mechanical ventilation but none in non-CHD patients, and 2 (4.4%) mortalities of CHD patients were noticed none in non-CHD patients. A review in Canada between 1988 and 1991 was evaluated for 260 children with CHD, hospitalized with RSV disease at 12 paediatric tertiary care centres, and 87 (33%) required intensive care and 49 (19%) required ventilation which is nearly similar to current study [46].

5. Conclusion

Our study demonstrates that most patients with pneumonia or recurrent pneumonia are likely to have an underlying pathology at the time of pneumonia. Recurrent ALRTI often occurred in children with history of congenital heart diseases (CHD) and is also associated with Congestive Cardiac Failure. Children with CHD are more vulnerable to recurrent respiratory tract infection. Considering that the children with CHD has an anatomical defect that causes hemodynamic disturbances of lung circulation, and ultimately put them at higher risk to suffer from recurrent respiratory tract infection than those who has no history of CHD. Children with hemodynamically significant CHD have a major risk of ARI, frequent pneumonia. The association of severity of ARI, specific infections and CHD requires multidisciplinary approach to prevent major cardiac and respiratory complications.

6. Recommendations

We recommend screening of all children presenting with LRTI for CHD in their first episode itself. Cardiac evaluation must be done in all cases of recurrent LRTI and failure to thrive.

7. Limitations of the study

Sample size of the current study was small and hence the results could not be extrapolated to the pediatric population. Moreover, due to unavailability of interventional pediatric cardiac surgery at our centre, the follow-up of CHD cases was difficult. There are comparatively lesser studies available in recent literature to compare the prevalence of CHD in initial episode of pneumonia.

Data availaibility statement

Data will be available to all the readers as per journal's rules.

Provenance and peer review not commissioned, externally peer-reviewed.

Ethical approval

APPROVED BY IEC VIA LETTER NO. 8597/HRH/2018 DATED: 04/12/2018.

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Nil.

Author contribution

1. Dr. Neeraj Kumar Jat: Data collection
2. Dr. D.K.Bhagwani: Supervision of the study
3. Dr. Namita Bhutani: Have written the manuscript
4. Dr. Urvashi Sharma: Data collection
5. Dr. Ram Sharma: Supervision of the study
6. Dr. Raju Gupta: Supervision of the study

Consent

Written informed consent was obtained from the parents of the patients for publication of this tudy and accompanying images. a copy of the written consent is available for review by the editor-in-chief of this journal on request.

Registration of Research Studies

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Guarantor

DR. NAMITA BHUTANI.

Declaration of competing interest

We do not have any conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2021.103111.

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