

THE UTILITY OF A CHEST RADIOGRAPH IN SCREENING COVID-19 PATIENTS

IN A PEDIATRIC TERTIARY GOVERNMENT HOSPITAL

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ABSTRACT

Background: COVID-19 continues to be a pandemic to this time, and chest radiography has been used as a first-line triage tool due to long turnaround times of real-time reverse transcription polymerase chain reaction (RT-PCR). Chest x-ray (CXR) alone has poor sensitivity in diagnosing COVID-19, though pediatric studies on this are scarce.

Objective: To evaluate the usefulness of a routine CXR as an adjunct to diagnosing suspected pediatric COVID-19. The radiographic characteristics in pediatric COVID-19 patients are also presented.

Methods: A cross-sectional study involved a retrospective chart review of 259 pediatric patients admitted in a tertiary hospital with COVID-19 signs and symptoms, with baseline CXR and SARS-CoV2 RT-PCR tests. Correlation of signs and symptoms with CXR findings to RT-PCR positivity was determined using univariate and multivariate logistic regression analysis.

Results: The study was composed of 259 pediatric patients (ages 0-18 years old). Of these, 35 had positive findings with RT-PCR (15%). Sensitivity of a CXR with pneumonia is at 62.9%, while specificity is at 39.3%. Overall accuracy of CXR findings leading to RT-PCR positivity is 42.5%. Ground glass or hazy opacities was the most common radiographic finding (45.5%), followed by reticular opacities (31.8%). Abnormalities were mostly distributed in the inner lung zone distribution with bilateral involvement (90%). Those with difficulty of breathing were more likely to have pneumonia on their CXR, though a finding of pneumonia on CXR did not significantly correlate to a positive RT-PCR.

Conclusion: Findings of pneumonia on a pediatric CXR may not necessarily lead to a positive SARS-CoV2 RT-PCR but correlating this with the patient's clinical course and symptoms may be beneficial in effectively triaging patients at the emergency room.

Keywords: covid-19, coronavirus, pediatric, children, radiograph, chest x-ray, CXR, screening, sensitivity, specificity

INTRODUCTION

COVID-19 was declared by the World Health Organization as a pandemic last March 2020 and since then, cases continue to rise worldwide with over 140 million cases in 219 countries and 3 million deaths as of April 2021.¹ In the Philippines, there have been over 900,000 COVID-19 confirmed cases with a ranking of 26th in countries with most cases, with over 15,000 deaths since the last year. The pandemic is still ongoing, and in the last 12 months, various advances in medical knowledge about the disease course, diagnostics and treatment regimen have been done globally. Diagnostic technologies have become widely available, but the gold standard remains to be the reverse-transcription polymerase chain reaction (RT-PCR). This method has several limitations: a relatively slow turnaround time (average of 2-7 days), with high cost and limited testing capacity in many countries.² Other imaging modalities, such as the chest radiograph, chest CT scan³ and lung ultrasound^{4,5} was found to

be useful to assess clinical features, predict likelihood of COVID-19, and detect disease severity and progression in various studies in adults.

In the pediatric population, chest findings are mostly nonspecific. Children seem to have milder forms of the disease, with a wider spectrum of clinical findings, lower hospitalization rates and lower mortality.⁶ Because children appear to be less infected with COVID-19, studies are scarce as to the use of chest imaging in this population. Meanwhile, the recommendations from the American College of Radiology still do not include chest CT or CXR as an upfront test to diagnose pediatric COVID-19, but they may still have a role in clinical monitoring.⁷ A chest CT is also not recommended as an initial diagnostic test for children with known or suspected COVID-19 pneumonia due to increased radiation sensitivity in children, as compared to adults, and increased cost and unavailability of CT scan machines.⁸ A CXR

can be useful in the clinical decision and management of children with suspected COVID-19, with lesser radiation risks and more readily available results.

Cases of COVID-19 in both the adult and pediatric population remain a problem in the country and worldwide. Problems with classification of these patients become inevitable, requiring immediate availability of RT-PCR results. Turnaround time of RT-PCR results is usually slow ranging from 24 hours to several days. A more readily available option is the chest x-ray with results becoming available within three to six hours. As an admission policy of the Philippine Children's Medical Center formulated in response to the pandemic, all patients to be admitted will have to be assessed at the triage if he/she is a COVID-19 suspect. This will determine where the patient will be admitted, either in the COVID ward or in the regular ward. Whether or not the patient presented with COVID-19 symptoms or not, all are required to have a

baseline chest x-ray. If the chest x-ray result shows pneumonia, he/she is tagged as a COVID-19 suspect. In local hospital data, patients with a normal CXR eventually turn out COVID-19 positive on RT-PCR upon subsequent testing. On the other hand, some admitted patients with abnormal CXR results subsequently turn out COVID-19 negative. It is left to the clinician's discretion for the treatment of these cases. We aimed to evaluate the usefulness of a routine chest radiograph as an adjunct to screening COVID-19 suspect patients upon admission, while awaiting the result of the RT-PCR.

OBJECTIVES OF THE STUDY

General Objective

- To evaluate the usefulness of a routine chest radiograph as an adjunctive screening tool in diagnosing suspected COVID-19 in a pediatric population

Specific Objectives

1. To describe the most common radiographic findings among confirmed COVID-19 pediatric patients
2. To determine the sensitivity, specificity, positive and negative predictive values, and likelihood ratio of a CXR finding and correlate it with the signs and symptoms of confirmed COVID-19 pediatric patients
3. To determine the risk factors for COVID-19, correlating the most common signs and symptoms, comorbidities and a positive CXR finding.

METHODS

This was a cross-sectional diagnostic study design which included a chart review of COVID-19 suspect admissions from March to December 2020 in a pediatric tertiary government hospital. Target population were

pediatric patients admitted as COVID-19 suspects at a tertiary government hospital from March to December 2020, who had a CXR and SARS-COV2 RT-PCR done during admission. Inclusion criteria were all pediatric patients 0 to 18 years of age of either sex, who presented at the triage/ER with signs and symptoms of COVID-19 (fever, cough, dyspnea, sore throat, coryza, diarrhea, myalgia, anorexia, nausea, vomiting, headache, altered mental status), with or without co-morbidities, who were admitted as a COVID-19 suspect case, with a chest x-ray and SARS-COV2 RT-PCR test done during admission. Admitted patients who had no COVID-19 symptoms but had a standalone finding of pneumonia on chest x-ray were also included in this study. Exclusion criteria were those who did not consent for admission to COVID ward, those who refused to undergo a chest x-ray and a SARS-COV2 RT-PCR test at admission, those with inaccessible CXR and SARS-COV2 RT-PCR results, and those who died at the triage and had no chest x-ray and

RT-PCR test done. Those who were admitted initially as a non-COVID-19 case, but subsequently developed COVID-19 symptoms and was tagged as a COVID-19 suspect during their hospitalization were excluded from this study. Considering all admissions to COVID ward from March to December 2020 as the total population of $n=794$, sample size was computed at 95% confidence level and 0.05 margin of error which requires a minimum of 259 subjects. Random sampling was applied to choose the 259 subjects and there were $n=35$ COVID-19 confirmed patients within the sample.

All admitted COVID-19 suspect patients were included until sample size was reached using systematic random sampling. The patient's demographics, including age, sex, signs and symptoms, comorbidities, date of admission, working diagnosis, chest x-ray result, SARS-COV2 RT-PCR result, and patient disposition (whether died or discharged) were recorded. The primary investigator obtained the list of patients from the hospital records, noting the

demographics, signs and symptoms and comorbidities, official chest x-ray results and the SARS-COV2 RT-PCR results (positive or negative) upon admission. The description of the chest x-ray findings solely relied on the official result released by the primary reading radiologist. Any abnormal finding noted on the CXR, aside from the finding of pneumonia, was recorded as well. These were all gathered in a tabular form. From these data, the sensitivity, specificity, positive predictive value, negative predictive value and likelihood ratio of the signs and symptoms together with the chest x-ray findings in those with positive SARS-COV2 RT-PCR results were computed. Data was collected using random sampling of all COVID-19 suspect patients admitted in the institution from March to December 2020 until the sample size was reached. Instruments included the hospital's in-patient census, patient medical records, review of chest x-ray description and official results via the RAMSOFT application of the hospital, and the SARS-COV2 RT-PCR results via the COVID

laboratory list. All data was typed in a Microsoft Excel document and stored in the researcher's laptop. Information in the worksheet included the patients' identifiers (age, sex) with date of admission, admitting signs and symptoms, comorbidities, initial working diagnosis, official chest x-ray result and description, SARS-COV2 RT-PCR result and patient's disposition.

Descriptive statistics, such as mean and standard deviation were used to present continuous variables, while frequency and percentage were used for categorical data. Univariate and multivariate logistic regression were applied to determine risk factors for COVID-19, which included the signs and symptoms, comorbidities and a positive CXR finding. Correlation between these factors and a positive RT-PCR results was done via chi square test. Additionally, diagnostic values such as sensitivity, specificity, accuracy, AUC (Area under the curve) and likelihood ratio was provided to show the discriminatory

capability of CXR in predicting positive RT-PCR results. Level of significance is at 5% while Medcalc Statistical software was used to carry out statistical calculations.

RESULTS

Among the 259 COVID-19 suspect patients, 35 (15%) were confirmed COVID-19 positive cases, while 224 patients (85%) were negative for COVID-19. The mean age of these patients (139 boys, 120 girls) was six years old, with a median of four years old (range 0 days to 18 years of age). Gender distribution is not significantly different, as both groups are mostly males. Among the total subjects, 62% had pre-existing comorbidities. Of these, 12% eventually turned out to be positive for COVID-19, while 88% were negative for COVID-19. The most common comorbidities were that of hematology/oncology, such as acute leukemia and solid organ tumors, followed by neurology, with epilepsy as the most common disorder. The top three most

frequent symptoms at the triage were difficulty breathing, fever and seizure. These are summarized in table 1.

Table 1. Profile of COVID-19 Suspects

	All (n=259)
Age (years), mean $\pm$ sd, (median)	5.98 $\pm$ 6.0
Sex, n, %	
Male	139 (53.7)
Female	120 (46.3)
Comorbidities	
With	161 (62.2)
Hematology/Oncology	47 (18.1)
Neurology	30 (11.6)
Gastroenterology	25 (9.7)
Renal Disease	19 (7.3)
Congenital Anomalies	13 (5.0)
Cardiovascular system	5 (1.9)
None	98 (37.8)
Signs and Symptoms	
Difficulty of breathing	65 (25.1)
Fever	52 (20.1)
Seizure	39 (15.1)

Table 2 summarizes the characteristics of the COVID-19 confirmed patients. 37% of these patients belonged to the one month to one year age group (13 of 35 patients), followed by those ages seven to 12 years at 20%. For the most common signs and symptoms at admission, nine of 35 (25.7%) presented with

difficulty of breathing, six patients (17.1%) had fever, and five patients presented with seizure (14.3%). 57% of the confirmed COVID-19 patients have co-morbidities. The most common comorbidities associated with these patients include chronic liver disease and leukemia at 20%, followed by solid organ

tumors at 15% (ependymoma, Wilms tumor and teratoma). In the clinical classification of these patients, six patients were evaluated as having mild disease, 15 patients had moderate disease, three patients had severe disease, and

11 patients were considered critical. COVID-19 severity and outcomes are seen in table 2 with moderate classification being the most common among the subjects and 71% recovered from the illness.

Table 2. CHARACTERISTICS OF COVID-19 CONFIRMED PATIENTS

Parameters	N = 35	%
Age		
Newborn (<1 month)	3	9
1 month to 1 year	13	37
2 to 6 years	6	17
7 to 12 years	7	20
13 to 18 years	6	17
Presenting Signs & Symptoms		
Difficulty of breathing	9	25.7
Fever	6	17.1
Bleeding (Melena/Hematochezia)	6	17.1
Seizure	5	14.3
Vomiting	3	8.6
Loose bowel movement	2	5.7
Headache	2	5.7
Others	2	5.7
Abdominal pain	1	2.9
Comorbidities	20	57
Leukemia & solid organ tumors	7	35
Chronic liver disease	4	20
Epilepsy	3	15
Prematurity	2	10
Renal disease	2	10
Others (malnutrition, MSUD)	2	10
Classification of severity		
Asymptomatic	0	0
Mild	6	17.1
Moderate	15	42.9
Severe	3	8.6
Critical	11	31.4
Outcome		
Died	10	28.6
Recovered	25	71.4

22 of 35 patients demonstrated pneumonia on chest radiograph (63%), while 12 of 35 (34%) had normal chest findings, and only one patient had a finding of cardiomegaly (3%) (Table 3). Among those with pneumonia, ground glass or hazy opacities was the most common finding at 46%, followed by reticular or linear opacities at 32%, and reticulonodular appearance at 14%. One of 22 patients showed

reticular opacities with concomitant bilateral pleural effusion, and only one patient showed a single consolidation pneumonia. 90% of pneumonia was found on the inner lung zones (central) with bilateral involvement (20 of 22), with only one finding of perihilar dominance and unilateral lung. Below are actual chest x-ray images showing the different radiographic findings (see figures 1 to 4).

Table 3. RADIOGRAPHIC FINDINGS OF COVID-19 CONFIRMED PATIENTS

Radiographic Findings	N = 35	%
Normal CXR	12	34.3
Cardiomegaly	1	2.8
Pneumonia	22	62.9
Pattern of lung opacities	N = 22	
Ground glass or hazy opacities	10	45.5
Linear or reticular opacities	7	31.8
Reticulonodular opacities	3	13.6
Reticular opacities with pleural effusion	1	4.5
Consolidation	1	4.5
Distribution	N = 22	
Perihilar dominant	1	4.5
Left lower lung involvement	1	4.5
Bilateral inner lungs	20	90.0

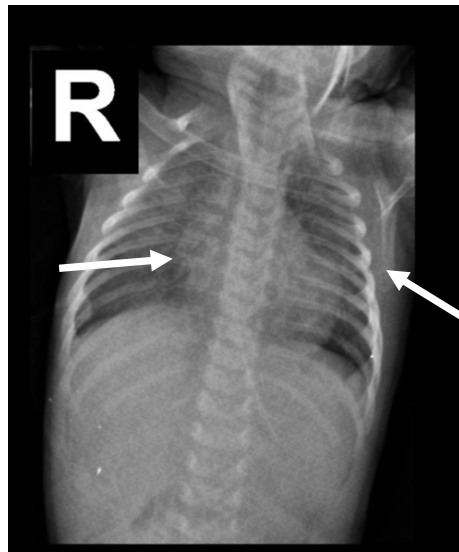


Figure 1. Pneumonia with ground glass opacities in the right lung and left upper lung (white arrows) in a 1 month old girl with a consideration of maple syrup urine disorder

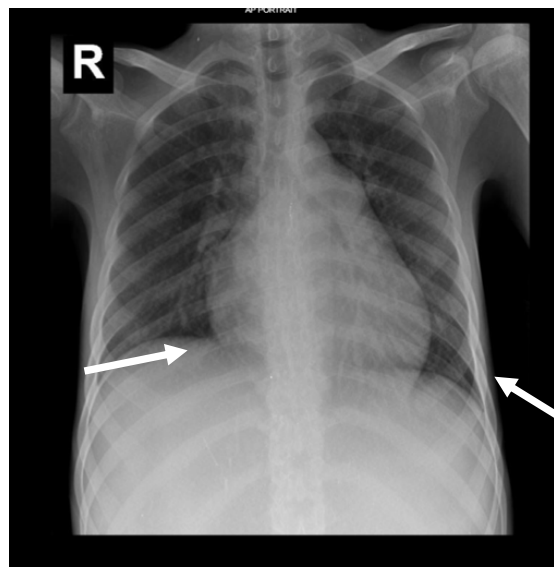


Figure 2. Pneumonia on bilateral inner lung zones showing reticular or linear opacities (white arrows) in a 16-year old male with chronic myelogenous leukemia

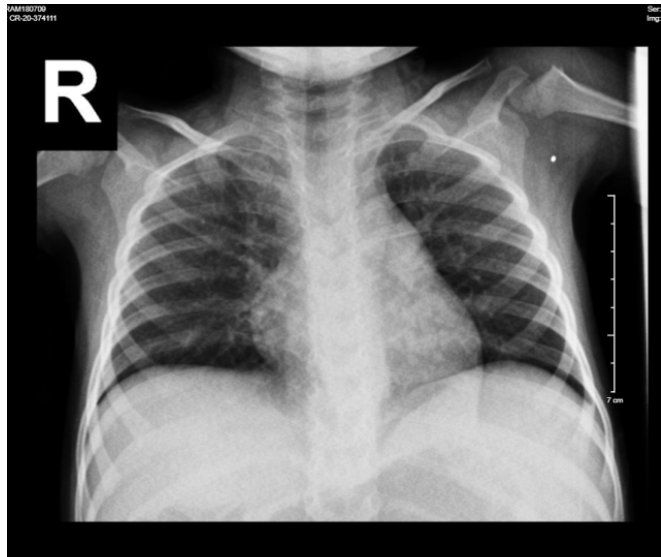


Figure 3. Pneumonia showing reticulonodular opacities (white arrows) in the bilateral inner lung zone distribution in a 3-year old boy with portal hypertension

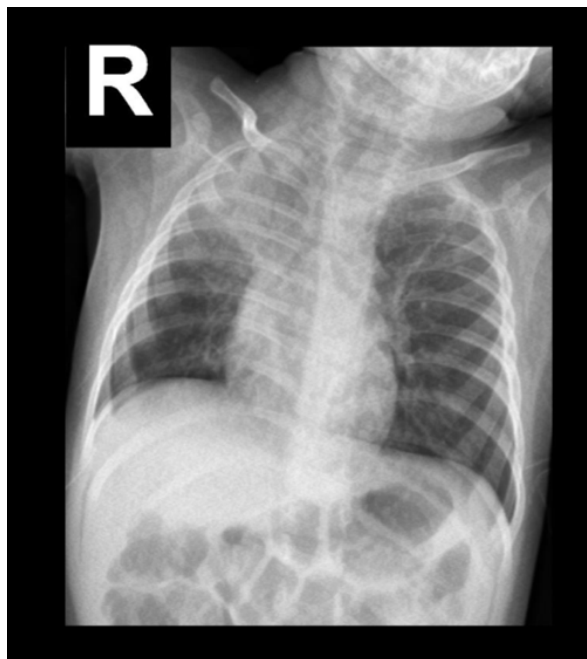


Figure 4. Pneumonia showing consolidation on the right upper lobe in a 6-month old boy with concomitant intussusception

Table 4 reveals the signs and symptoms of all the study subjects with their subsequent chest x-ray results. Only difficulty of breathing

(p=.0001) had a significant association with having pneumonia on chest x-ray.

Table 4. ASSOCIATION OF SYMPTOMS AND CHEST X-RAY RESULTS

	Normal	Others	Pneumonia	p value
Signs and Symptoms				
Difficulty of breathing	8 (8.7)	4 (44.4)	53 (33.5)	0.0001*
Fever	25 (27.2)	1 (11.1)	25 (15.8)	0.0730 ^{ns}
Seizure	15 (16.3)	1 (11.1)	21 (13.3)	0.8392 ^{ns}
LBM	6 (6.5)	1 (11.1)	4 (2.5)	0.1137 ^{ns}
Bleeding	11 (12.0)	1 (11.1)	12 (7.6)	0.4113 ^{ns}
Abdominal related pain	3 (3.3)	0 (0.0)	10 (6.3)	0.6150 ^{ns}
Cough	2 (2.2)	0 (0.0)	7 (4.4)	0.6324 ^{ns}
Vomiting	6 (6.5)	0 (0.0)	7 (4.4)	0.7240 ^{ns}
Headache	1 (1.1)	0 (0.0)	3 (1.9)	1.0000 ^{ns}
Weakness	4 (4.3)	0 (0.0)	2 (1.3)	0.3516 ^{ns}
Edema	1 (1.1)	0 (0.0)	7 (4.4)	0.4477 ^{ns}
Poor Activity	3 (3.3)	0 (0.0)	1 (0.6)	0.2562 ^{ns}
Others	8 (8.7)	1 (11.1)	6 (3.8)	0.1725 ^{ns}

**significant, ns not significant*

At presentation, each patient underwent both chest radiograph and RT-PCR testing. 158 of 259 patients (61%) had pneumonia on their chest x-ray, however, 136 (of 158, 86%) turned to be negative for RT-PCR. The sensitivity or the probability that the chest x-ray shows pneumonia when the RT-PCR result is positive is 62.86% (95% CI 44.92% to

78.53%), while the specificity or the probability that the chest x-ray is either normal or showed other findings when the RT-PCR is negative is only 39.29% (95% CI 32.85% to 46.01%). Overall accuracy is only 42.47% (95% CI 36.34% to 48.74%) while resulting area under the curve is only 0.51 (95% CI 0.45 to 0.57) with p value of 0.8379, denoting that

a chest x-ray cannot significantly discriminate positive from negative RT-PCR results. The probability that patients with pneumonia on CXR truly have COVID-19 (positive predictive value) is computed at 13.92% (95% CI 10.94% to 17.57%) and the probability that patients with normal CXR truly do not have

COVID-19 (negative predictive value) is at 87.13% (95% CI 81.03% to 91.48%). Additionally, resulting positive and negative likelihood ratio are 1.04 (95% CI 0.79 to 1.36) and 0.95 (95% CI 0.60 to 1.50) respectively. See table 5.

Table 5. DIAGNOSTIC ACCURACY OF CHEST X-RAY RESULTS IN PREDICTING POSITIVE SARS-COV2 RT-PCR RESULTS

CXR results	Positive RT-PCR	Negative RT-PCR
Pneumonia	22 (62.9%)	136 (60.7%)
Others/Normal results	13 (37.1%)	88 (39.3%)
Total	35	224
	Values	95% CI
Sensitivity	62.86	44.92 to 78.53
Specificity	39.29	32.85 to 46.01
Accuracy	42.47	36.34 to 48.74
Positive Predictive Value	13.92	10.94 to 17.57
Negative Predictive Value	87.13	81.03 to 91.48
Positive Likelihood ratio	1.04	0.79 to 1.36
Negative Likelihood ratio	0.95	0.60 to 1.50
Area under the curve	0.51	0.45 to 0.57
p value	0.8379 ^{ns}	

^{ns} not significant

Univariate logistic results show that none of the variables, such as age, sex, comorbidities, signs and symptoms and chest x-ray results

significantly predict positive RT-PCR results. Bleeding (p=.0919) turned out to have some potential to predict RT-PCR positivity (Table

6). Specifically, resulting odds ratio of 2.37 (95% CI 0.9 to 6.5) for bleeding symptoms suggest that having this symptom at admission slightly increases the chances of a positive RT-PCR. On chest x-ray findings, having pneumonia resulted to an odds ratio higher than one (1.07, 95% CI (0.5 to 2.3), which indicates that it can slightly increase the chances of positive RT-PCR results. Chest x-

ray, together with the variables that have a p value of <0.20 were run on a multivariate logistic regression. Results show the top five signs and symptoms, and those who presented with these symptoms on admission, with a finding of pneumonia on CXR did not have any significant potential to affect COVID-19 positivity.

Table 6. DETERMINING PREDICTORS OF POSITIVE SARS-COV2 RT-PCR RESULTS

	SARS COV		Univariate			Multivariate		
	Positive	Negative	OR	95% CI	p value	OR	95% CI	p value
Age (years)	5.8 ± 5.9, (4.0)	6.0 ± 6.0, (4.0)	0.99	0.9 to 1.1	0.8567 ^{ns}	-	-	-
Sex								
Male	21 (60.0)	118 (52.7)	1.35	0.7 to 2.8	0.4203 ^{ns}	-	-	-
Female	14 (40.0)	106 (47.3)	-	-	-			
Comorbidities								
With	20 (57.1)	141 (63.2)	0.78	0.4 to 1.6	0.4903 ^{ns}	-	-	-
None	15 (42.9)	82 (36.8)	-	-	-			
Signs and Symptoms								
Difficulty of breathing	9 (25.7)	56 (25)	1.04	0.5 to 2.3	0.9278 ^{ns}	-	-	-
Fever	6 (17.1)	46 (20.5)	0.8	0.3 to 2.0	0.6418 ^{ns}	-	-	-
Bleeding	6 (17.1)	18 (8.0)	2.37	0.9 to 6.5	0.0919 ^{ns}	2.55	1.0 to 55.2	0.0694 ^{ns}
Seizure	5 (14.3)	32 (14.3)	1.00	0.4 to 2.8	1.0000 ^{ns}	-	-	-
Vomiting	3 (8.6)	10 (4.5)	2.01	0.5 to 7.7	0.3094 ^{ns}	-	-	-
Chest X-Ray Findings								
Normal	13 (37.1)	88 (39.3)	-	-	-			
Pneumonia	22 (62.9)	136 (60.7)	1.10	0.5 to 2.3	0.8090 ^{ns}	1.12	0.5 to 2.4	0.7655 ^{ns}

**significant, ns not significant*

DISCUSSION

This study reports the diagnostic accuracy of a chest x-ray as a screening tool in triaging pediatric patients during the COVID-19 pandemic. A chest x-ray is often the first imaging study used to evaluate a pediatric patient with signs and symptoms of respiratory distress, such as cough and fast breathing. Chest radiography, at least in adults, is less sensitive than a computed tomography scan in identifying COVID-19 pneumonia. However, we avoid CT scan as an initial imaging study in children due to increased radiation sensitivity and cost effectivity.⁹ A CT scan is recommended when there are already findings in the CXR of a pediatric patient and with progressive clinical deterioration.

CXR alone has limited sensitivity (62.86%) and poor specificity (39.29%), with an overall accuracy of 42.5% in diagnosing COVID-19 in the pediatric population. This is consistent with other studies in the adult population where sensitivity ranged from 51.9% to 94.4% and specificity ranged from 40.4% to 88.9%.¹⁰ This is in comparison to the gold standard, which is the SARS-CoV2 RT-PCR nasopharyngeal and

oropharyngeal swab, where the sensitivity is between 71% to 98% and the specificity at 95%.

¹¹ Of the 35 patients (of 259, 13%) who tested positive for COVID-19 with RT-PCR, 22 patients (63%) showed pneumonia on chest radiograph.

The main feature of ground glass or hazy opacities on chest radiography in pediatric COVID-19-related pneumonia is consistent with previously published articles in both the adult and pediatric population, although, the distribution of lung opacities in adults are usually peripheral in location. In a study by Palabiyik, F.,¹² ground glass opacities were seen in 41% of pediatric patients, 5% with consolidation and 36% with a combination of both. Serrano et al also found central ground glass opacities in 85.7% of pediatric COVID-19 patients.¹³ The Philippine Academy of Pediatric Pulmonologists describe typical pediatric chest findings for COVID-19 as: bilateral peripheral and/or subpleural ground-glass opacities and/or consolidation, while indeterminate findings are nonspecific and consist of unilateral or bilateral peripheral and central GGO and/or consolidation or bilateral peribronchial opacities, or diffuse GGO and/or

consolidation. Atypical findings, being uncommon, are described as unilateral lobar or segmental consolidation, central unilateral or bilateral GGO and/or consolidation, single round consolidation, presence of pleural effusion and/or lymphadenopathies.¹⁴ Only one of 22 patients presented with consolidation on the right upper lobe of the lungs, and one of 22 patients showed pneumonia with bilateral pleural effusion. This study found that distribution is mostly central, rather than peripheral, in contrast to adults, which is consistent with atypical findings of pediatric COVID-19 in terms of distribution of radiographic lesions. Duan et al observed the same, that children often have a combination of peripheral and central distribution of pneumonia.¹⁵ Serrano et al also concluded that peribronchial opacities were the most common finding in pediatric x-rays and may be a nonspecific response of the bronchus to any viral infection. Moreover, peripheral distribution in children may not be as common as in adults.¹³ Among the COVID-19 positive patients, 34% still had normal chest x-ray findings. In a study by Foust et al., he noted pediatric chest

radiography may show normal findings, along with the other typical findings.⁹ This is consistent with the fact that imaging may not yet show any findings at the onset of the illness, especially without respiratory symptoms, even though the RT-PCR is positive.¹⁵

In children, symptoms of COVID-19 are often nonspecific, although fever and cough remain the most common symptoms worldwide. Other symptoms such as flu-like illness (nasal obstruction, runny nose), gastrointestinal symptoms, sore throat, myalgia, fatigue are variably common as well. Most may even be asymptomatic, and most children have been infected unknowingly. Of the 259 subjects, the three most common signs and symptoms at presentation were difficulty of breathing, fever and seizure. Among those who eventually became positive for COVID-19, difficulty of breathing, fever and bleeding were the top three. This study revealed that a patient presenting with difficulty of breathing may be more likely to have pneumonia on his/her chest x-ray, whichever gender, age or whether or not he/she had

comorbidities. Those who also presented with bleeding symptoms were more likely to be COVID-19 positive on swab test.

CONCLUSION

COVID-19 continues to be a pandemic to this time and the gold standard for diagnosis remains to be the SARS-CoV2 RT-PCR. A chest x-ray has limited sensitivity and specificity in its diagnosis in the general population; however, it is a reliable adjunctive tool for triaging patients who present at the emergency room. The most common finding in pediatric COVID-19 patients with pneumonia is ground glass or hazy opacities with central distribution and bilateral involvement, which is often accompanied by fever, difficulty of breathing, and bleeding. Once these are met at the presentation of a patient, COVID-19 is highly suspected and triaging may be easier. Overall, history taking and accurate clinical assessment remain vital in the care of pediatric patients during this pandemic, and with the benefit of a chest x-ray, this may provide the clinician with a prompt assessment and a more accurate disposition of patients.

This study had several limitations. First is that the patients were not followed through to their hospital course, and serial chest radiographs and repeat SARS-CoV2 RT-PCR swabs were not monitored and correlated to the patients' clinical outcomes. Second, since our subjects involved pediatric patients, reported signs and symptoms among the younger age group are based on the parents' reports alone, which may lead to inaccurate recording of symptoms at the onset. Third, the official CXR results were not verified by another radiologist. Therefore, recommendations include follow through of the clinical course of the patients, together with the serial imaging and swab procedures, to assess the sensitivity and specificity of chest x-ray through time and throughout the course of the COVID-19 illness, coinvestigation with another radiologist/s to review the chest x-ray results in consensus to validate findings and classify according to a severity grading system, and lastly, comparison of the accuracy between the use of CXR, chest CT and chest ultrasound may also be done in future studies.

REFERENCES:

1. COVID-19 map. Johns Hopkins coronavirus Resour. *Cent* <https://coronavirus.jhu.edu/map.html> (accessed 20 Feb 2021).
2. Konrad R, Eberle U, Dangel A, *et al.* Rapid establishment of laboratory diagnostics for the novel coronavirus SARS-CoV-2 in Bavaria, Germany, February 2020. *Eurosurveillance* 2020;25.
3. Landini, *et. al*, The Role of Imaging in COVID-19 Pneumonia Diagnosis and Management: Main Positions of the Experts, Key Imaging Features and Open Answers, 2020 Oct;30(Suppl 2):S25-S30. doi: 10.4103/jcecho.jcecho_59_20. Epub 2020 Oct 27
4. Raiteri, *et. al*, Lung Ultrasound Is Often, but Not Always, Normal in Healthy Subjects: Considerations for COVID-19 Pandemic, 2021 Jan 6;11(1):82. doi: 10.3390/diagnostics11010082
5. Lichter, *et. al*, Lung ultrasound predicts clinical course and outcomes in COVID-19 patients, 2020 Oct;46(10):1873-1883. doi: 10.1007/s00134-020-06212-1. Epub 2020 Aug 28.
6. Nino G, Zember J, Sanchez-Jacob R, Gutierrez MJ, Sharma K, Linguraru MG. Pediatric lung imaging features of COVID-19: A systematic review and meta-analysis. *Pediatr Pulmonol.* 2021 Jan;56(1):252-263. doi: 10.1002/ppul.25070. Epub 2020 Nov 2. PMID: 32926572
7. Litmanovich DE, Chung M, R Kirkbride R, Kicska G, P Kanne J. Review of Chest Radiograph Findings of COVID-19 Pneumonia and Suggested Reporting Language [published online ahead of print, 2020 Jun 9]. *J Thorac Imaging.* 2020;10.1097/RTI.0000000000000541. doi:10.1097/RTI.0000000000000541
8. <https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Recommendations-for-Chest-Radiography-and-CT-for-Suspected-COVID19-Infection>

9. Alexandra M. Foust, Grace S. Phillips, Winnie C. Chu, Pedro Daltro, Karuna M. Das, Pilar Garcia-Peña, Tracy Kilborn, Abbey J. Winant, and Edward Y. Lee, International Expert Consensus Statement on Chest Imaging in Pediatric COVID-19 Patient Management: Imaging Findings, Imaging Study Reporting, and Imaging Study Recommendations, Radiology: Cardiothoracic Imaging 2020 2:2
10. Islam N, Ebrahimzadeh S, Salameh J-P, Kazi S, Fabiano N, Treanor L, Absi M, Hallgrimson Z, Leeflang MMG, Hooft L, van der Pol CB, Prager R, Hare SS, Dennie C, Spijker R, Deeks JJ, Dinnes J, Jenniskens K, Korevaar DA, Cohen JF, Van den Bruel A, Takwoingi Y, van de Wijgert J, Damen JAAG, Wang J, McInnes MDF, Cochrane COVID-19 Diagnostic Test Accuracy Group. Thoracic imaging tests for the diagnosis of COVID-19. Cochrane Database of Systematic Reviews 2021, Issue 3. Art. No.: CD013639. DOI: 10.1002/14651858.CD013639.pub4.
11. Watson, J, Whiting, P, Brush, J, Interpreting a covid-19 test result, Centre for Academic Primary Care, Bristol Medical School, University of Bristol, Bristol, UK; Sentara Healthcare and Eastern Virginia Medical School, Norfolk, VA, USA
12. Palabiyik F, Kokurcan SO, Hatipoglu N, Cebeci SO, Inci E. Imaging of COVID-19 pneumonia in children. Br J Radiol 2020; 93: 20200647
13. Serrano et, al. Pediatric chest x-ray in covid-19 infection, European Journal of Radiology 131 (2020) 109236
14. Rapid Advice On The Pulmonary Care In Pediatric Covid-19, PAPP COVID Task Force, Philippine Academy of Pediatric Pulmonologist, May 2020
15. Duan, Yn., Zhu, Yq., Tang, Ll. *et al.* CT features of novel coronavirus pneumonia (COVID-19) in children. *Eur Radiol* **30**, 4427–4433 (2020). <https://doi.org/10.1007/s00330-020-06860-3>
16. Kapoor, D., Kumar, V et al, Impact of Comorbidities on Outcome in Children with COVID-19 at a Tertiary Care Pediatric Hospital, Department of Pediatrics, New Delhi, May 14, 2021