

Pediatric COVID-19 Pneumonia

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Abstract

SARS-CoV-2 virus caused a pandemic that started in 2020, and infections with the virus continue to date of this review. Children have been infected by this virus, although with less severe clinical manifestations compared to adults. Children with underlying diseases and obesity were more susceptible to severe disease. Pediatric infection with the virus resulted in systemic manifestations in addition to pneumonia. In this article, we review the mechanism of lung infections, clinical manifestations, ventilation abnormalities, diagnosis, the role of imaging, and the treatment options for COVID 19 pneumonia in children.

Keywords: COVID 19 infection, pneumonia, CT findings in COVID 19 pneumonia.

(J Med J 2023; Vol. 57 (3): 268-281)

Received

Accepted

December, 30, 2021

June, 22, 2022

Introduction

The Severe Acute Respiratory Syndrome Virus 2 (SARS-CoV-2) caused a global pandemic that started at the end of 2019. By June 2021, 174 million people had been infected, and 3,700,000 had died [1]. Children accounted for about 13% of infected patients [2]–[4] at the start of the pandemic, and later recently closer to 20% [5]. The virus causes a milder illness in children than in adults; about 2.5-4% of infected children needed hospitalization [6], and 0.00-0.04% of all pediatric patients with coronavirus disease 19 (COVID 19) infections resulted in death [7]. In a CDC report, 33% of pediatric COVID 19 admissions required ICU admission [6] [8]. Patients with underlying disease, immunodeficiencies, and overweight pediatric patients were at risk for more severe disease. [9] [10]. Pediatric patients with severe disease had pneumonia [11] [10] [12]; usually, they presented with ground-glass opacities and

consolidations [12] [13] [14]. With the continued emergence of new variants [15], and the fact that vaccination in children is lagging vaccination in adults, the US Food and Drug Administration (FDA) only approved the COVID vaccine for 5-11 year old children on October 29th 2021 [16] and for children over six months of age on June 2022 [17]; the percentage of pediatric hospitalizations compared to the adult hospitalization will increase, as seen in a report for the Center for Disease Control (CDC) that showed the percentage of admissions in the age group 5-11 increased from 1.5 to around 3% in the last few months 2021 [18].

SARS-CoV2 virus infection in children

Coronaviruses (CoVs) are zoonotic positive-strand RNA viruses. Seven coronaviruses have been identified to date that caused disease in humans. The first four Human CoVs (HCoVs) cause mild upper respiratory tract symptoms; these viruses seem endemic in the pediatric population. The other three viruses can cause lower lung disease and an acute respiratory distress syndrome picture; the SARCoV-1, Middle East Respiratory

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Syndrome (MERS), and SARS-CoV-2 viruses. The four strains of HCoV that cause mild disease in humans were detected in equal numbers in inpatient children and controls (asymptomatic children). The pediatric patients who were admitted were more likely to be coinfecting with other viruses. Children who were symptomatic and only had one of the HCoVs detected usually were more likely to be under three years of age and have an underlying heart disease or a chronic illness[19][20]. The other three HCoVs caused widespread disease. SARS-CoV1 in 2004; the virus caused lower respiratory tract infection and pneumonia most likely caused by an exaggerated host response, and children under 12 years had mild illness [21]. MERS also caused pneumonia and Acute Respiratory Distress Syndrome (ARDS), with a mortality rate of about 35.6%, children under 20 years of age only compromised 1.1-4.2 % of infected patients [22]. SARS-CoV-2 infection has been relatively mild in children, with a hospitalization rate of 8 per 100,000 in children younger than 18 years of age compared to 164.5 in adults [23][24]. The reason for the decreased severity of coronavirus infection in children compared to adults remains unknown. Contrary to other viruses such as influenza, children younger than two are more likely to recover from SARS-CoV-1 and 2 and the MERS virus; it is also interesting to note that children are usually more prone to severe respiratory infections caused by almost all other respiratory viruses.

SARS-CoV2 virus mechanism of lung infection in children

The RNA genome of SARS-CoV-2 codes for at least four structural proteins; envelope proteins, membrane proteins, nucleocapsids, and spike proteins (S) that facilitate entry into the human cell by acting as a ligand for the human angiotensin-converting enzyme 2 receptors (ACE-2). The virus infects cells with a high concentration of ACE-2 receptors, facilitating viral entry and replication in the cytoplasm.

The ACE-2 protein is expressed in several tissue types but primarily on the surface of type

2 alveolar epithelial cells; these cells are also known to produce surfactant that prevents lung collapse and, therefore, are vital to the gas exchange function of the lungs. Increased expression of human ACE-2 has been shown to enhance disease severity in mice infected with SARS-CoV-1, indicating that ACE-2 dependent viral entry is critical for the infectious process [25].

When the SARS-CoV-2 virus is inhaled, the S protein binds to the ACE-2 receptor and creates an S protein-ACE-2 complex. The complex is then proteolytically processed by type 2 transmembrane serine protease (TMPRSS2). This process leads to cleavage of ACE-2 and the activation of the S protein, which facilitates viral entry through endocytosis into the target cell.

Viral entry causes self-replication of the SARS-CoV-2 RNA, and the virus starts spreading; this is presumed to happen in the mucosal epithelium of the upper respiratory tract at the beginning of the infection. Further multiplication occurs in the lower respiratory tract because of the abundance of expression of ACE-2 receptors in type 2 alveolar cells. When most of the cells are infected, several pathological processes occur that can lead to ARDS. Pneumocyte destruction, decreased surfactant production, viremia-induced cytokine storm, and impaired vascular permeability lead to diffuse alveolar damage. It appears that several factors of the pathogenesis of COVID-19 can change the severity of illness. The age-dependence of any of these elements may help explain the decreased clinical severity seen in children with COVID-19. [25]

The immune response caused by SARS-CoV-2 infection is divided into two phases: first, an immune-protective phase and then an activation phase of the cytokine storm. The second phase causes more severe clinical manifestations. A healthy adaptive response can control the virus and prevent inflammation caused by the viral infection in the first phase. If the immune system cannot control this phase, cell damage occurs in organs with high concentrations of ACE-2, especially pneumocytes. Eventually, it progresses to the

second phase by releasing cytokines and chemokines like Interleukin 6, interleukin 10, and interferon, and the recruitment of inflammatory cells, which mediate lung damage and progression toward ARDS [26]. Signs of diffuse alveolar damage, like desquamation of pneumocytes, hyaline membrane formation, and the presence of fibromyxoid cells with interstitial lymphocyte infiltration, have been found in histopathological samples of a patient who died of COVID-19 [27]. Clinically speaking, SARS-CoV-2 causes interstitial pneumonia[28][29]. A possible complication of this strong inflammatory response is Multisystem Inflammatory Syndrome of Children (MIS-C), which happens when inflammation becomes generalized. This appears to be a post-immunological reaction caused by non-neutralizing IgG antibody and made worse by a cytokine storm that leads to generalized inflammation that can resemble toxic shock syndrome or an atypical Kawasaki's disease [28][29]

Several theories have been proposed to explain why children appear to be less frequently and severely affected by COVID-19. However, they remain assumptions because of the lack of scientific evidence on the subject. The immune response of children is different from that of adults, which progressively deteriorates with age; to an extent, preschool children have a repertoire of immune cells 5–10 times larger than that of a 50-year-old and 20 times larger than that of an 80-year-old. It is still not clear to which extent this may play a role in controlling the cytokine signaling effects caused by the SARS-CoV-2 virus related to severe outcomes in adults[29].

Another factor could be that the SARS-CoV-2 also infects the endothelial cells and causes vasculitis, the resulting damage activates the coagulation pathways and leads to the formation of microthrombi. This could explain why adult patients with diabetes and hypertension are at risk for more severe disease. Children have an endothelium that is less susceptible to damage as compared to adults. Not only that, but they also have a different

coagulation system, which makes them less prone to abnormal clotting [30].

SARS-CoV2 pneumonia in children

The clinical manifestations of SARS-CoV-2 in the pediatric population are quite vast and can vary from entirely asymptomatic to severe respiratory distress necessitating intensive care [29]. SARS-CoV-2 affects both the upper and lower respiratory tracts, with an incubation period that can last up to 15 days, averaging around 3 to 7 days, similar to that in adults [31] [32]. Infants presented with vague symptoms, including poor feeding, loss of appetite, irritability, and dyspnea [33] [34]. The most frequently documented symptoms in children under the age of nine were fever (46%), cough (37%), headache (15%), diarrhea (14%), and sore throat (13%). In adolescents, however, headache (42%), cough (41%), fever (35%), myalgia (30%), sore throat (29%), dyspnea (16%), and diarrhea (14%) were the most common symptoms [35] [36]. The fever in the pediatric population had a mean duration of 3 days, as opposed to 10 days in adults [33]. Rhinorrhea, nausea, vomiting, abdominal pain, anosmia, dysgeusia, and seizures were also reported, although to a lesser degree [30] [37]. Furthermore, non-specific dermatological findings were also uncommonly reported, including maculopapular, urticarial, and vesicular eruptions. “COVID toes”, an atypical cutaneous finding unique to SARS-CoV-2 and can be its sole initial presentation, is characterized by painful purple and red papules on toes and fingers [38].

The severity of SARS-CoV-2 pneumonia infection in the pediatric population can be classified clinically as asymptomatic, mild, moderate, severe, and critical [39] [40] [41]. In the asymptomatic presentation, patients only had a positive SARS-CoV-2 serology and PCR test with no symptoms. In the mild presentation, patients mostly complained of upper airway symptoms such as nasal obstruction and sneezing, which were occasionally associated with fever, cough and other gastrointestinal symptoms. In the moderate presentation, patients complained of a more severe fever and

predominantly dry cough that resulted in difficulty breathing. This particular presentation was distinguished radiologically by lung abnormalities suggestive of interstitial pneumonia. The severe presentation was typified by the existence of hypoxemia, associated with respiratory distress signs such as tachypnea and groaning, along with cyanosis, neurological manifestations, food refusal and signs of dehydration. The critical stage is characterized by disease deterioration to respiratory failure necessitating mechanical ventilation, in addition to signs of septic shock, refractory metabolic acidosis, multiorgan dysfunction syndrome (MODS), and coagulation disorders [29] [42] [43] [33]. While most pulmonary ailments result in respiratory alkalosis [44], SARS-CoV-2 pneumonia is unique in that it causes metabolic acidosis, which is one of its characteristic findings. This can be due to the disruption of gas exchange in the lungs, inflammation, and thrombosis, which all ultimately lead to hypoxia that in turn facilitates the switch to anaerobic metabolism. This explains the elevated lactic acid levels seen in SARS-CoV-2 pneumonia patients [44].

According to several studies, no specific age group among the pediatric population contracted SARS-CoV2 pneumonia more than the other, refuting the claim that a younger age exerts a protective effect [41] [46] [47]. The severity and symptomatology of SARS-CoV-2 pneumonia in the pediatric population did not exceed that of other common viral pneumonia, with fever and cough being the most common symptoms overall [41]. Fever was mostly low to moderate in temperature, and was shorter in duration than in viral pneumonia [41]. The prevalence of fever among pediatric SARS-CoV2 patients was much less than the adult population [48]. In addition, the number of cases that necessitated intensive care was less than in viral pneumonia [41]. Not only that, but the inflammatory markers (e.g., CRP, PCT, ESR, IL-6, LDH), biochemical markers indicative of tissue or organ damage (e.g., ALT, AST, CK, CK-MB), and disseminated intravascular coagulopathy (DIC) markers were lower in pediatric SARS-CoV-2 patients. This

might possibly suggest that the virus weakly activates the innate immune system, explaining the mild manifestations of the disease in the pediatric population [41].

Risk factors for severe SARS-CoV-2 lung infection

Obesity, respiratory illness, and a compromised or suppressed immune system have been reported as risk factors for severe infection in children. Obesity was the most common comorbidity in hospitalized COVID 19 children; there was also a strong association between obesity and severe disease requiring mechanical ventilation in children two years and older[36]. A retrospective study from Wuhan, China, reported an increased risk of mortality in patients aged 14-15 years who had an elevated body mass index BMI[49]. Another study found that 30% of the hospital admissions were obese (14/46), but no relationship was observed between ICU admission and obesity[50]. Obesity was also found to be a risk factor in a pediatric systematic review and meta-analysis. The exact mechanism by which obesity contributes to increased mortality is still unknown[10].

Because COVID 19 is primarily a lung disease, it was assumed that children with chronic lung disease and asthma would have worse conditions, but this did not turn out to be the case. A study looking exclusively at COVID 19 patients requiring PICU care did not have a higher proportion of asthmatic patients, nor did the admissions to the general floor. [9] Underlying respiratory conditions were only found in 4% of all hospital admissions and 10% of ICU admissions[51]. Also, a systematic review and meta-analysis of 67 studies did not report asthma as an underlying risk factor for COVID 19 disease[52]. A study from Italy showed that the prevalence of asthma among the COVID 19 patients was lower than in the general population[53].

Available data about the risk of COVID-19 in patients with immunodeficiency or immunosuppression seems to indicate that it is a significant risk factor. Immunodeficiencies were reported in 3.8% (808) of cases and were associated with a fourfold increase in COVID

19 pneumonia and an eightfold increase in the risk of admission to the hospital [54]. One study from Spain showed that 15% of the total hospital admissions in a month were immunosuppressed. However, another study from England showed that being on an immune suppressant was not associated with increased COVID 19 hospital admission [51][55].

The incidence of viral co-infection ranged from 3.4-47% in various studies[37]. Some studies showed that there were no associations between viral co-infection and the severity of symptoms and ICU admissions. However, other studies did indeed show that co-infection was associated with more severe disease[56][57].

Pediatric SARS-CoV-2 CXR and Computed tomography (CT) patterns

The American College of Radiology

recommends pediatric radiologic imaging for children with a confirmed COVID-19 diagnosis and mild symptoms with pre-existing comorbidities, and for patients with moderate to severe symptoms of the disease. Chest X-ray is the first-choice exam, but because of its lower sensitivity and specificity, lung involvement cannot be excluded in children with a laboratory-confirmed diagnosis of COVID-19. CT imaging is indicated in cases where pulmonary embolism is suspected and in cases of clinical worsening [58].

An algorithm for requesting imaging studies in pediatric patients with suspected COVID-19 pneumonia based on the recently published international expert consensus statement on chest imaging in pediatric COVID-19 patient management has been suggested [59] (Table 1).

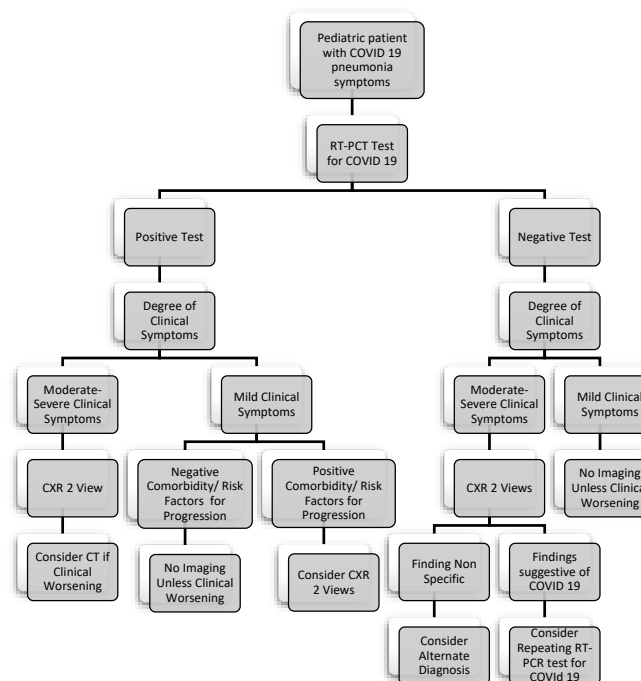


Table 1: Algorithm for ordering imaging studies in children with COVID 19 infection

Pulmonary abnormalities on CXR were seen in 46–90% of symptomatic cases. The most common radiologic findings were peribronchial thickening, ground-glass opacities, consolidation, and pleural effusion. Pulmonary

abnormalities were unilateral in 55% and bilateral in 45% of affected children, with no significant difference between the left and right lungs, but with more involvement of the lower lobes (figure 1). Although these radiological

findings typically resolve after recovery from the disease, they have been reported to persist in about 16% of cases[60][61].

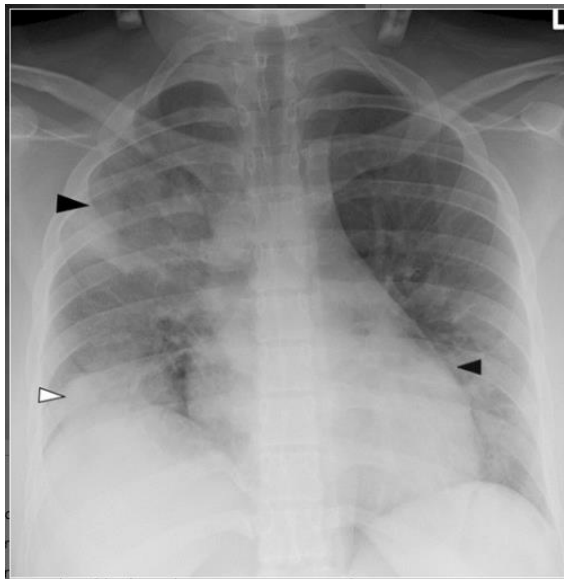


Figure 1 A 17-year-old with COVID 19 infection showed patchy peripheral consolidation (white arrowhead) and ground-glass opacification (black arrowheads) in the right upper lobe and bilateral lower lobes[57].

The most commonly observed CT abnormalities in pediatric COVID-19 pneumonia are mixed bilateral ground-glass opacities and consolidation in peripheral and/or subpleural distributions [60]. In the initial phases of the infection, a localized area of inflammation with a surrounding rim of ground-glass may be seen ("halo" sign); this likely relates to localized inflammation and surrounding vascular congestion. The initially localized inflammation begins to spread to adjacent alveoli and more diffuse ground-glass opacification is observed on the CT indicating evolving alveolitis. After the infection becomes more established and the infected alveoli get filled with fluid and inflammatory cells, the CT shows consolidative opacities (figure 2).

Several systematic reviews and meta-analyses have been published about imaging findings in pediatric patients with COVID 19 pneumonia [14][13][63], the largest article

included about 1000 children, the results of that analysis were as follows: (1) More than a third of pediatric patients with COVID-19 had normal chest CTs (2) The most typical pediatric chest CT findings of COVID-19 were ground-glass opacities in 37.2% of the cases. The presence of consolidations or pneumonic infiltrates was seen in 22.3%. (3) The pulmonary imaging findings in children with COVID-19 were, in general, less frequent and less severe than in adult patients, and only 27.7% had bilateral lesions. (4) Typical pulmonary imaging features of viral respiratory infections in the pediatric population, like increased perihilar markings and hyperinflation, were not reported in pediatric patients with COVID-19[13].

Another review of 517 cases showed that "the incidences of ground-glass opacities, ground-glass opacities and consolidations, consolidations, reverse halo signs, crazy paving signs, pleural effusion, bronchopneumonia-like signs, air bronchograms, and increased lung markings were 40%, 25%, 10%, 2%, 4%, 1%, 15%, 12%, and 31%, respectively. Pericardial effusions were found in the computed tomography images of adult COVID-19 cases but were rarely seen in the CT images of pediatric COVID-19 patients. The incidences of bilateral lesions, unilateral lesions, and peripheral lesions were 35%, 22%, and 26%, respectively"[63].

Lung Ultrasound

Ultrasonography of the lungs does not expose the patient to radiation or sedation. The use of lung ultrasound has been evaluated in COVID-19 pneumonia diagnosis and follow-up; the main ultrasound findings of 10 children with COVID-19 were B lines (70%), pleural irregularities (60%), white lung (10%), and subpleural thickening (10%)[62]. Lung ultrasound may help support diagnosis and follow up of COVID-19 pneumonia, as it shows a typical pattern of diffuse interstitial lung syndrome and correlates with chest CT findings [65]

Treatment

Supportive care should be provided to all

children with COVID 19 infection. Cases must be isolated, require adequate fluids, electrolytes and calories, and management of the fever. Supportive care should be provided for all pediatric patients with COVID-19 as recommended by various national committees [65][66][67]. Supportive care is also required for patients with severe or critical COVID-19[67]. Most children with COVID-19 improve with supportive care, even those with severe disease [65]. Children with SARS-CoV-2 infection and severe lower respiratory tract disease usually require hospital admission. Children with mild COVID-19 infection may only require hospital admission if they are at risk for severe illness due to underlying conditions (e.g., immunosuppression) or are febrile infants younger than 30 days. Respiratory status may change suddenly after approximately one week of symptoms [68]

Supportive care:

Respiratory support, which includes the supplementation of oxygen and ventilation, invasive and noninvasive. Noninvasive ventilation can be provided in the form of C-PAP or high flow nasal cannula, caution must be taken when using high flow nasal cannula as it may lead to aerosolization of the virus, and extra care will be needed ensure the safety of the health care workers. Critically ill children should be transferred to a pediatric intensive care unit. If there is no response to non-invasive ventilation or onset of ARDS, invasive mechanical ventilation should be considered and, ultimately, extracorporeal membrane oxygenation (ECMO) [40].

Supportive care also includes monitoring for cytokine release storm, by monitoring the blood pressure and biomarkers, like CRP, D-dimer, ferritin, lactate dehydrogenase (LDH) and interleukin-6 (IL-6)

Pharmacological treatment:

Provision of thromboprophylaxis: in children admitted with COVID 19 pneumonia, the decision to provide thromboprophylaxis should be made on a case-by-case basis depending on the risk of thromboembolic disease in the child.

Empiric antibiotics: the use of antibiotics

depends on the clinical picture and the likelihood of community-acquired pneumonia and bacterial superinfections, which appear to be rare in COVID 19 pneumonia [70]. Cultures and microbial studies should guide the discussion to start antibiotics.

Antiviral medications: the multicenter interim guidance on the use of antiviral agents for children with COVID-19 and other experts state that antiviral therapy should be considered on a case-by-case basis because of the lack of evidence of the effectiveness of antiviral medications in pediatrics. Antiviral medications should be given to children with severe SARS-COV-2 infection or those with mild or moderate disease with an underlying medical condition that could increase the risk for severe disease.

Remdesivir: data regarding the benefit of this medication in the pediatric population is lacking, but in adults, it decreased recovery time. The World Health Organization (WHO) suggests not using it in hospitalized patients. In the US it has been approved for children >12 years of age and weight >40kg, and it has an emergency use authorization for children who weigh>3.5kg [71]. The current dosing is ≥ 3.5 to <40 kg: 5 mg/kg intravenous (IV) loading dose on day 1, followed by 2.5 mg/kg IV every 24 hours. ≥ 40 kg: 200 mg IV loading dose on day 1, followed by 100 mg IV every 24 hours.

Remdesivir in combination with baricitinib the FDA in the US has issued an emergency use authorization for baricitinib to be used in combination with remdesivir in patients older than two years of age who are admitted to the hospital with COVID-19 and require oxygen supplementation or ventilatory support [72], there is not enough information about the benefits and risks of this combination therapy in children with COVID-19. It has some antiviral effects and immunomodulatory effects.

Hydroxychloroquine and chloroquine: are not recommended to be used in children [73].

Lopinavir/Ritonavir: has not been recommended for use in pediatrics[74].

Glucocorticoids: Data supporting its benefit in children are still lacking. In the adult

population, there has been evidence of decreased mortality. children with severe COVID 19 infection who require supplemental oxygen or ventilation, or who are at risk for disease progression can be given a low dose of glucocorticoids. Although the WHO strongly recommends systemic glucocorticoids for patients with severe or critical COVID-19 in adults, they acknowledge that the applicability of the recommendation for children is uncertain because children were underrepresented in the clinical trials supporting benefit [75], the dosing for glucocorticosteroids is: Dexamethasone 0.15 mg/kg orally, IV, or nasogastrically (NG) once daily (maximum dose 6 mg) or prednisolone 1 mg/kg orally or NG once daily (maximum dose 40 mg), or methylprednisolone 0.8 mg/kg IV once daily (maximum dose 32 mg), or hydrocortisone, for neonates (<1 month of age): 0.5 mg/kg IV every 12 hours for 7 days followed by 0.5 mg/kg IV once daily for 3 days and for children ≥ 1 month: 1.3 mg/kg IV every 8 hours (maximum dose 50 mg; maximum total daily dose 150 mg).

Tocilizumab: IL-6 monoclonal antibody, the routine use of it is recommended in adults who are on supplemental oxygen and steroids, mechanical ventilation and extracorporeal membrane oxygenation [76]. There has been an emergency use authorization (EUA) for

children over 2 years of age who also are on supplemental oxygen and systemic steroids. The dose is 12 mg/kg in children weighing <30 kg, 8 mg/kg (max: 800 mg) in children > 30kg to be repeated once after 8 hours if there is no response [77,78]. However, the risk and benefits of the treatment are not clear yet and require further evaluation [78]

Outpatient management with antiviral medications have been recommended in patients who are at high risk for progression to severe disease like; patients with one or more underlying medical conditions, patient who are immunocompromised, patients who are dependent on medical technology, unimmunized, and obese patients [79]. The medications that have been recommended for use are nirmatrelvir-ritonavir which is a protease inhibitor and prevents viral replication and approved for children over 12 years of age [80] and molnupiravir which is a nucleoside analogue that also prevents viral replication and has been approved for patients older than 18 years of age [81] both are given for five days. The medications have to be prescribed early after infection usually within 5-7 days of illness, and have been shown to decrease severity of infection and work on different COVID-19 variants [79].

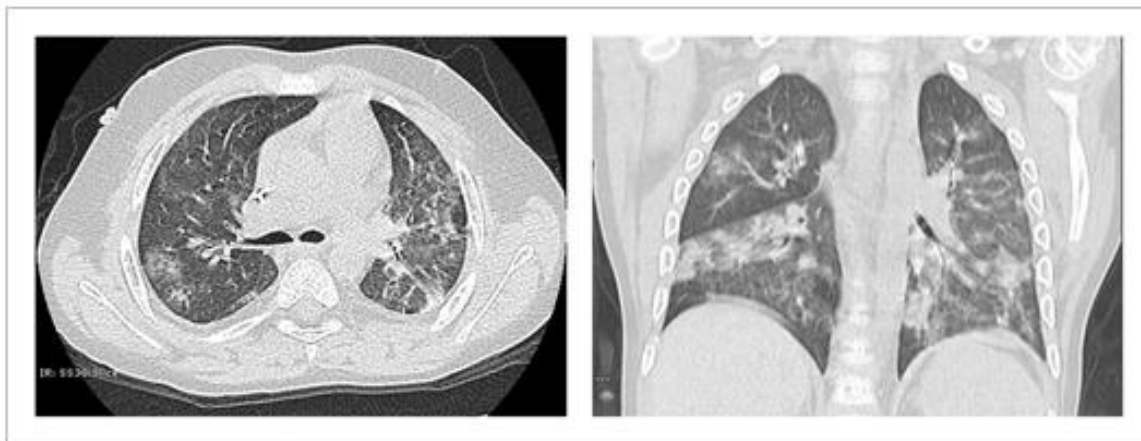


Figure 2 Typical radiological appearance of the most common abnormalities identified in pediatric COVID-19 cases. Chest CT of a 5-year-old male with PCR-confirmed SARS-CoV-2 infection. Images show multifocal scattered ground and patchy consolidations with a peripheral distribution. [12]

CONCLUSION

In conclusion, SARS-CoV-2 pneumonia primarily affects older children as opposed to most other respiratory viruses. In addition, CT scan findings of pediatric SARS-CoV-2 pneumonia were comparable to those of adult

patients affected by the virus. Hence, further research is needed in order to reach a more targeted anti-viral treatment.

Consent to publish this review article, once approved by reviewers.

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التهاب الرئة الناتج عن فيروس كورونا عند الأطفال

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الملخص

هذا البحث المرجعي يهدف الى دراسة التهاب الرئة الناتج عن التهاب فيروس كورونا عند الأطفال. لقد بدأت جائحة كورونا منذ عام 2020 وحتى هذا التاريخ. لقد أصيب الأطفال بعدوى فيروس الكورونا ولكن الحالات كانت أقل شدة من ناحية المضاعفات السريرية بالمقارنة مع البالغين، في هذا البحث ستم مناقشه إصابات الكورونا عند الأطفال و بالذات التهاب الرئة، و بحث اليه التهاب الرئة عند الأطفال و اختلافها عن إصابات البالغين. وكذلك سيركز البحث على الخصائص السريرية والمخبرية وبالذات الصور التشخيصية لالتهاب الرئة الناتج عن التهاب الفيروس عند الأطفال والذي لم يلقى الاهتمام البحثي المماثل لالتهاب الرئة عند البالغين. في هذا البحث المرجعي ستم مراجعه اخر العلاجات التي توصل اليها العلم لمعالجة الحالات الشديدة لالتهاب الرئة وكذلك الحالات التي هي عرضة لأصابه شديدة عند الاطفال. و خصوصا الأدوية المضادة للفيروسات.

الكلمات الدالة: التهاب فيروس الكورونا، التهاب فيروس الكورونا عند الأطفال، التهاب الرئة، صور الرئة الطبقية لالتهاب الرئة عند الإصابة بفيروس كورونا.