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COVID-19: The Pediatric Perspective

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Since the appearance of the novel corona virus disease 19 (COVID-19) from Wuhan in China, there have been a lot of researches to uncover the hidden clues that may help in eliminating the outbreak. In a short period of time, the disease has infected millions of people around the globe and was declared as a pandemic by the world health organization (WHO). Different subgroups of the community have been studied and reports have described the course of the disease among pregnant ladies, elders, immunodeficient patients and patients with chronic diseases. However, this review aimed at describing the novel COVID-19 among children and adolescents. The review discusses the prevalence, symptoms, diagnostic investigations, management, and the role of pharmacotherapy of COVID-19. In general, children have a milder course of diseases compared to adults. The symptoms include fever, diarrhea, abdominal pain, cough, fatigue, and other non-specific symptoms. The diagnosis is usually made with a serological test of a body fluid sample from saliva or nose. The role of radiography in the forms of chest X-ray and computed tomography (CT) is not of great benefit to the children. For mild presentations of the disease among children, the management is mainly supportive and there is no indication for antiviral therapy or specific

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pharmacotherapy except for fever lowering agents like Paracetamol. In terms of prevention, children aged 12 or more can be vaccinated for the objective of preventing the spread of infection, inducing antibody release, and shortening the recovery period.

Keywords: Pediatric, COVID-19, symptoms, diagnosis, vaccination.

ABBREVIATIONS

WHO : World Health Organization
CT : Computed Tomography
MISC : Multisystem Inflammatory Syndrome
RT-PCR : Real-Time Polymerase Chain Reaction
CRP : C-Reactive Protein
PPE : Pooled Preference Estimate
LDH : Lactate Hydrogenase
GGO : Ground-Glass Opacities
PARDS : Pediatric Acute Respiratory Distress Syndrome

1. INTRODUCTION

Coronavirus Disease 2019 (COVID-19) is a multisystem viral infection that majorly affects the human respiratory system [1-2]. The pathogen shares up to 96% of genetic similarity with the variant in bats, that is why experts trace the beginning of the disease in the animals [1,3]. The occurring of SARS-CoV-2 infection in children is due to the interaction with adult family members who contract the disease from the community [4]. COVID-19 is transmitted through body fluids like saliva, sputum, and sweat during physical contact, coughing, sneezing, or touching contaminated surfaces. Current SARS-CoV-2 treatment guidelines are focused on the most affected adult population, with little emphasis on solutions to the pediatric population [5]. Thus, studies have been developed to identify the clinical manifestations of the disease among children, yet it is important to strive to develop COVID-19 management standards tailored to the young population [6-7]. This paper involves reviewing current literature on the prevalence, clinical manifestations, diagnosis, prognosis, and management of pediatric COVID-19 patients.

2. MATERIALS AND METHODS

This paper is based on study reviews and meta-analysis reports of recent studies on pediatric COVID-19. Appropriate articles were accessed on Pub Med, PMC, Frontiers in Medicine, Google Scholar, MDPI, NCBI, and BMC. Search terms included “pediatric COVID-19, SARS-CoV-2 in children, coronavirus disease prevalence, disease risk factors, SARS-COV-2 hospitalization, and COVID-19 diagnosis”. The majority of articles selected for review were published between during the years 2020 and 2021. The chosen articles were filtered after full review and only high-quality papers that serves the current topic were included.

3. RESULTS AND DISCUSSION

3.1 Prevalence and Epidemiology

Reports consistently reveal that teenagers and young children are the least affected by COVID-19. Fatalities, symptoms severity, and other complications are also less devastating in young people compared to older patients.

Four months after the reports of first cases, 200 000 patients had contracted the infection, with 4% mortality rate [8]. Notably, confirmed pediatric cases were substantially low compared to the situation in the adult population among all the nations. Thereafter, children remain particularly safer across different parameters. Infection rates among those aged from 6 to 14 years are currently between 21-25% [6]. Moreover, 84% of pediatric infections are non-critical and do not require advanced care [6].

3.2 Clinical Manifestations

Most young persons with SARS-CoV-2 are asymptomatic or have mild to moderate symptoms like fever and cough [9-12]. The cause of the mild course observed in the young population is unclear [13]. However, some researchers have linked it to the fact that children have a highly functional body defense mechanism against SARS-CoV-2 [9]. The rate of critical care needs is significantly high among children below one year and those with underlying risk factors due to the vulnerability of their body organs. The SARS-CoV-2 death rate in children above 12 years is 0.18%, which shows that the disease is not a serious threat to adolescents. Patel established that pediatric COVID-19 fatalities could be even lower than the available data as only seriously sick children, who are exceptionally vulnerable to severe

symptoms, participated in the experiment. The majority of pediatric COVID-19 patients experience fever, abdominal pain, and breathing difficulty [14]. Diarrhea, fatigue, and vomiting are among the most common symptoms of SARS-CoV-2 in children [15].

Multisystem inflammatory syndrome in children (MISC), is rare in young sufferers based on the 12% admission rate [14]. MISC refers to a combination of respiratory, gastrointestinal, circulatory, and neurological complications like ataxia and frailty [16]. The leading causes of severe COVID-19 in children are co-occurring ailments such as tuberculosis and diabetes [14]. Generally, young people are significantly safe from advanced prognoses due to their highly responsive antibodies, which prevent viral multiplication, thereby slowing down or preventing disease progression [14].

3.3 Laboratory Findings

COVID-19 disease can be tested using real-time polymerase chain reaction (RT-PCR) tests, serologic methods, and imaging techniques [11, 17]. However, RT-PCR is the standard strategy for diagnosing SARS-CoV-2 as it detects the viral attack with a 62% accuracy rate within the first 24 hours after contracting the infection and over the accuracy rate is up to 80% after three days [17]. The testing procedure for conducting the method entails sample collection and extraction [18]. Subsequent steps include purification of the virus, PCR amplification, and nucleic acid analysis. Specimens for the method include nasal swabs, sputum, lung fluids, and saliva [17,19]. Sample extraction and RNA magnification can be automated or done manually by different technological instruments. The RT-PCR test identifies viral genetic materials upon entering the human body [17].

Serologic methods involve investigating antibody response upon detecting SARS-CoV-2 in the body. The virus can be diagnosed using rapid tests and advanced laboratory techniques [17]. Serologic methods should be used limitedly since there are concerns over their accuracy and pathogen specificity. For instance, practitioners report that rapid tests and laboratory diagnosis can give negative results in newly infected individuals, especially within the first seven days of viral attack [17]. Rapid serological methods are useful for tracking disease progression since they easily detect the SARS-CoV-2 pathogen than CPR tests [20]. Additionally, blood analysis techniques are important for community interventions because they give results faster and are more accurate than rapid tests.

The course of SARS-CoV-2 in pediatric sufferers is tracked using PCR test and lymphocyte analysis. However, there is currently no defined profile of abnormalities on the points of infection that can be used as a standard for confirming the presence of COVID-19 virus in young patients [21]. The phenomenon is thought to be since the disease severity rate among young children and adolescents is significantly low. There is currently no conclusive evidence on why the majority of children do not indicate major symptoms [21-22]. Some scholars believe that a lower risk of exposure and absence of serious underlying illnesses contributes to the harmlessness of the syndrome to most children.

Although there is inconsistency in the outlook of the virus based on laboratory reports, recurring abnormalities are recorded in serious conditions. Leukocyte count tends to increase by only 13%, and minor deformities are present in cell structure. C-reactive proteins (CRP) are released in small amounts in reaction to the entry of the virus into the body [23]. CPR produces a pooled preference estimate (PPE) count increase of 18% compared to 37-69% in patients with influenza [23]. White blood cells replicate rapidly when an infection occurs with chronic diseases like heart and lung conditions. For example, Henry et al. found that CD4+ cell count rises significantly in young individuals with the disease. The report contradicts the trend in the adult COVID-19 patients, where leukopenia is a common finding. Another unusual characteristic of SARS-CoV-2 is that the levels of biomarkers, such as procalcitonin and serum lactate hydrogenase (LDH), are high in both older and pediatric patients. The variations in the outcomes suggest that laboratory tests cannot be used as the only strategy for determining the presence of COVID-19 in children [23].

3.4 Imaging findings

Radiology experts and physicians recommend chest CT scanning and radiography as the safest and accurate methods for capturing the damages caused by the virus on the lung and the abdomen [24]. Factors such as sensitivity, accuracy, and the effect of radiation on young people must be considered when making imaging decisions. Radiography is preferable for critically sick patients, defaulters of home-based

care, and children with hospital-acquired pneumonia [24]. Radiologists should also be careful to avoid misleading observations due to the effect of conditions like influenza and lung defects [24]. Open discussions between physicians and referring providers concerning the choice of appropriate techniques based on disease prevalence and individual practice methodologies can ensure effective reporting.

3.4.1 Chest radiography

Chest radiography is considered less sensitive than CT scanning for COVID-19 detection, especially in older patients. However, it is recommended for children suspected of having SARS-CoV-2 infection due to symptoms like high body temperature, breathing difficulties, and nausea. Although chest radiography is inappropriate for imaging in children, it is effective for tracking disease development. Ground-glass opacities (GGO) in COVID-19 positive patients increase with the duration of infection [24]. Generally, chest radiography does not provide a correct presentation of disease severity and can lead to increased hospitalization or mortality when relied upon by physicians to make treatment decisions [24].

Chest radiography manifestations in COVID-19 pediatric patients can be classified as typical, indeterminate, atypical, and negative imaging [24]. Typical radiography is related the cases of COVID-19 pneumonia, which exists individually, or as bilateral peripheral, subpleural GGO, or consolidative forms [24-25]. Indeterminate imaging implies a non-specific result, including unilateral, multifocal, and diffuse GGOs [24,26]. Concisely, it captures features of viral pneumonia and defects on small airways. The atypical radiography is helpful in spotting defects associated with bacterial pneumonia, such as lobar consolidation. Lastly, negative chest radiographic representation focuses on structured details since it is not applicable in ordinary imaging. It is appropriate for SARS-CoV-2 patients without pneumonia or related respiratory problems [24].

3.4.2 Chest CT

Nino et al. did a single-arm meta-analysis study of 20 articles to identify lung imaging features in young COVID-19 patients. They established that one third of the participants had normal chest computer tomography (CT) results, with only 27.7% diagnosed with lesions on both sides [27]. Several scholars have also established that chest CT scanning does not show deformed site appearances in children, even though it is the most accurate technique for COVID-19 [28]. Notably, the method is not recommended for screening young patients as risk of radiation exposure may overcome its benefits. Researchers are considering replacing radiation-based scanning with lung ultrasound (LUS) if its sensitivity, effectiveness, and accuracy are within acceptable standards [28].

3.4.3 Comparing adult and pediatric imaging findings

In general, about 37% of children with COVID-19 present with GGO compared to 80% of adult cases based on chest CT scanning [27]. Additionally, 35.7% of PCR-confirmed pediatric SARS-CoV-2 cases captured with the same method have normal imaging results. Contrarily, COVID-19 infected adults generally present with similar chest and abdomen abnormalities. Images in children mostly depict mild to moderate levels of infection, unlike adults whose cases tend to escalate quickly due to the effects of chronic lung [27]. Overall, studies on chest CT scanning show that young people having SARS-CoV-2 are less likely to develop complications than grownups, even when they have underlying comorbidities [27].

3.5 Management

Management of pediatric COVID-19 entails Symptomatic treatment, supportive care, and infection control. The choice of intervention depends on the disease's severity [29]. Young COVID-19 patients with lethargy, oral, and respiratory complications should be admitted for further assessment and care [30]. The potencies of SARS-CoV-2 pharmacological solutions, especially immunomodulatory and antiretroviral medications, are not known. Medications should be used on a clinical trial basis to enable close monitoring of efficacy and side effects [5]. COVID-19 treatment solutions like the use of anticoagulants, and immunity boosting therapies are recommended. For moderately ill individuals, fever management drugs such as Paracetamol and Ibuprofen can be prescribed to control the fever [5].

The treatment for COVID-19 pneumonia should be modeled on the pediatric management strategy for pediatric acute respiratory distress syndrome (PARDS). The management entails

oxygenation, ventilation and the prescription of antibiotics and antifungal drugs [5,29,31]. Evidence supports antiretroviral therapy, although drugs with unknown results must be avoided, Lopinavir and ritonavir are potent and can be used under careful monitoring of patient conditions after taking the drugs [32]. Generally, oxygenation, ventilation, immunoregulation, and antiretroviral therapies are appropriate for institutionalized young COVID-19 patients.

Pediatric SARS-CoV-2 can alternatively be managed through home-based care, whereby suspected cases are tested and treated in the community [5]. Treatment is not necessary for mildly sick and asymptomatic patients because they are not at risk of serious health complications [33]. Concerns over the worsening of the health of COVID-19 infected children prevent many people from taking advantage of community-based treatment programs. Home management of patients without serious symptoms can help overcoming the health, social, and economic challenges encountered in the hospital settings. Indeed, cost and waiting time are serious barriers to effective treatment in busy healthcare institutions.

3.6 Role of pharmacotherapy

Pharmacological COVID-19 treatment strategies are discouraged for use in pediatric patients due to the lack of evidence on the effectiveness and safety. Existing recommendations are based on observations and studies among adult patients [34]. Thus, drug therapy should be applied on a case-to-case basis, especially in critical situations. Physicians recommend interferon-alpha by nebulization as one of the most potent pediatric antiretroviral SARS-CoV-2 medications because it hampers the multiplication of the virus, thereby preventing disease progression [34]. Hydroxychloroquine is not scientifically backed as a reliable SARS-CoV-2 drug despite its popularity when the pandemic began [34]. Antibiotics such as azithromycin can only be prescribed in patients presenting with co-occurring bacterial infections [10].

Corticosteroids are used in combination with antiretroviral drugs to manage pediatric patients above 12 years and weighing 40kg or more [16]. Significantly, all categories of children are pharmaceutically managed under close monitoring through the clinical trial strategy. Corticosteroids are effective for immunoglobulin regulation and inflammation prevention [16]. They are appropriate for COVID-19 sufferers who are diagnosed with Kawasaki disease and other conditions that cause swelling in blood vessels and internal body organs [16]. Anakinra, a biological agent, treats COVID-19 infected children presenting with serious lung swelling [35]. Co-occurring infections and conditions are important determinants of the choice of the treatment.

3.7 Immunization

Prolonged suffering from COVID-19 symptoms is devastating, and the effects can last for half a year after successful treatment. Young patients may struggle with fatigue, breathing complications, and poor sleep patterns when recovering from SARS-CoV-2 [36]. Vaccination reduces disease severity and long-standing symptoms, which may impair effective recovery if not treated on time. The main goal of immunizing children is to reduce their chances of contracting and spreading the SARS-CoV-2 virus. Only children older than 12 years should be vaccinated because they appear to be at a higher risk of developing severe complications than younger individuals [37]. Generally, immunization helps to reduce the length of disease and the recovery period of infected children.

3.8 Prognosis

Shekerdemian et al. conducted a study in 46 hospitals in North America to investigate the prognosis of COVID-19 in pediatric patients. They reviewed the medical records of 48 children who were admitted and properly followed up after discharge. PCR tests showed that 33 patients needed critical or intensive care. Thirty-eight participants were given non-intensive ventilation treatment, and only two died. They confirmed that the progression of the virus is significantly slow and less severe in children compared to adults. Additionally, they observed that only 35% of clinics that enrolled in the experiment recorded admissions [38]. Furthermore, they found a high survival rate among children with SARS-CoV-2 since only two of the subjects expired COVID-19 development has favorable outcomes since most of the participants, including the ones who recovered successfully, had critical underlying sicknesses [38]. The most common comorbidity was respiratory distress, although some severely ill subjects had obesity. Patients who were admitted to the pediatric intensive care unit were

diagnosed with seizure and circulatory malfunction [38].

The poor COVID-19 prognosis in children is due to the low prevalence of chronic conditions like obesity, cardiovascular ailments, and neurological impairments. Severe outcomes are caused by shortness of breath and gastrointestinal problems like diarrhea and vomiting [39-40]. Apart from underlying diseases, lactate dehydrogenase and high leukocyte count are also predictors of hospitalization. More adolescents than younger children become incapacitated and need intensive care to survive. The cause of the difference in pathogen replication patterns and disease severity in the two categories of pediatric sufferers is unknown [1]. Overall, the determinants of COVID-19 progression differ significantly between children and adults, and the phenomenon is responsible for the difference in rates of hospitalization and deaths.

4. CONCLUSION

Children contract COVID-19 mainly from adults with whom they regularly interact with, such as family members and close relatives. Fortunately, the disease has a poor progression in young sufferers, and the symptoms do not require critical care in most cases. Accurate and early diagnosis is important for timely and proper treatment of COVID-19. Therefore, children should be tested for the disease as soon as they start having known symptoms of COVID-19 infection, or when they interact with people who have tested positive for the virus. The recommended diagnostic methods include RT-PCR, serology, CT scanning, and chest radiography. The choice of a test technique is based on specificity, accuracy, effectiveness, safety, and the ability to detect a pathogen soon after entering the body.

Interventions for treating pediatric SARS-CoV-2 focus on controlling its spread, reducing the duration of sickness, and shortening the recovery period. Mild symptoms do not require any treatment because they disappear soon after a person is infected. A moderate COVID-19 disease type presenting with serious fever can be managed at home through supportive care. However, severely ill children must be hospitalized to enable effective treatment of co-occurring risk factors such as breathing problems and cardiovascular complications. Vaccination is a reliable measure for protecting young people against COVID-19 and reducing its prevalence in the population because it helps to reduce the spread of the virus in the community and hinders the virus replication rate. Overall, early diagnosis of COVID-19 in children is essential for effective treatment and prevention of serious complications.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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