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REVIEW PAPER

COVID-19 physiotherapeutic approach in pediatrics: literature review

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Abstract

Objectives: To present the main characteristics, diagnosis and physiotherapeutic approach of pediatric patients infected with COVID-19. **Methods:** This is an integrative literature review carried out from February to June 2020 regarding the physiotherapeutic approach in children diagnosed with COVID- 19. The search was performed in the PubMed database with the keywords "coronavirus", "pediatric", and "physiotherapy" crossed by through the boolean "AND" operator in the past four months. Articles that addressed only the subtype COVID-19 in pediatric patients were included and duplicate articles were excluded. In addition, research was carried out on protocols/articles from the Ministry of Health and Associations. **Results:** 273 articles were found in the PubMed database; however, 25 were included according to the selection criteria previously determined, in addition to 1 articles/association protocols that were also included. **Conclusions:** It was verified through this integrative review that the main characteristics of pediatric patients infected by COVID-19 are: mean age of involvement of 7 years; transmission by direct and/or indirect contact with respiratory droplets; different pathophysiology of adults due to different immune response; and mild symptoms with a good prognosis. The diagnosis is given by the clinical picture and categorized by severity: asymptomatic, mild, moderate, severe, and very serious. Among the proposed approaches, the following stand out: oxygen therapy, invasive mechanical ventilation, maintenance of the elevated headboard (30º-45º), prone position, and early mobilization.

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INTRODUCTION

The viral family of Coronaviruses (CoV) has been known since the 1960s, and is named for its crown appearance. Human CoVs are categorized into groups (alpha, beta, gamma and delta) and subdivided into 7 species[1]. Of these, 2 of the Betacoronavirus subfamily were further studied, as they caused Severe Acute Respiratory Syndromes in humans, SARS-CoV (in China in 2002, transmission by cats) and MERS-CoV (in Saudi Arabia in 2012, transmission by camels and dromedaries). In late 2019, a new species was identified, also belonging to the Beta group, named by the World Health Organization (WHO) as the crown virus 2019, SARS-CoV2 responsible for causing COVID–19[2].

It is believed that COVID-19 is transmitted by viruses from infected bats, but these must enter a host animal to continue evolving, mutating and recombining and then spreading to humans. Recent studies have shown that the pangolin (a mammal, with scales resembling the armadillo) is a potential host animal for COVID-19, with about 99% similarity with an infected human strain[3]. Epidemiological investigations show that the original source of this new Coronavirus is the Wuang Seafood and Wildlife Market in China, where, during the trade process, the virus was transmitted from animal hosts to humans and then through contact was disseminated, resulting in the current pandemic[2].

The number of infected persons grows exponentially in various parts of the world, something that generates an alert situation. In Brazil, there is no consistent information demonstrating the exact number of infected people in the general population due to the large number of underreporting, especially in the pediatric population, as they are mostly oligosymptomatic or asymptomatic[4]. In January 2020, the first case of COVID-19 was confirmed in a child in China, and as the pandemic spread, there was an increasing number of cases and deaths reported in this population, and from this, greater attention was directed to the children, thus resulting in a range of studies for this group[2].

As previously exposed, COVID-19 is a recent disease that instigates researchers around the world due to the need for knowledge regarding the involvement of various organs and systems. Understanding the repercussions of this virus is imperative for intensive and non-intensive healthcare professionals, including physical therapists, as many are being recruited to care for these patients in different scenarios.

Therefore, the aim of the present study is to present the main characteristics (way of transmission and mean age of onset, pathophysiology and symptoms), diagnosis and the physical therapy approach of pediatric patients infected with COVID-19.

METHODS

This is an integrative literature review conducted from February to July 2020 regarding the physical therapy approach to children diagnosed with COVID-19. The search was performed in the PubMed database with the keywords Coronavirus, Pediatric and Physiotherapy crossed using the Boolean AND operator in the last five months. We included papers that addressed the main characteristics in pediatric patients (way of transmission and mean age of onset; pathophysiology; main symptoms and degrees of severity); the diagnosis; general therapies and physical therapy interventions. The inclusion criteria were papers that addressed only the COVID-19 subtype in pediatric patients. In addition, we added protocols/papers from the Brazilian Association of Cardiorespiratory Physical Therapy and Intensive Care Physical Therapy. Papers with duplicate information and literature reviews were excluded.

RESULTS

We found 273 papers in the PubMed database; however, 25 were included according to previously determined selection criteria. In addition, we included 1 protocol of the Brazilian Association of Cardiorespiratory Physical Therapy and Intensive Care Physical Therapy, which addressed early mobilization in pediatric patients with COVID-19.

Main characteristics of covid-19 in pediatrics: form of transmission and mean age of onset

The main route of transmission of this virus is between humans, from contact (direct or indirect) through droplets or with the spread of aerosols. Fecal-oral and mother-to-child transmissions are still under investigation[3] although there is already a rare report of vertical transmission[5], of these, only 1.6% were infected[6].

We found that the average age of involvement of the infant population by COVID-19 is seven years, ranging between one and thirteen, although there are reports of newborn involvement[7]. Children and neonates with COVID-19 are most often infected by the family group and have good prognoses[8]. They are associated with the rapid spread of the virus, which has an incubation period of two to fourteen days[9].

Main characteristics of covid-19 in pediatrics: physiopathogenesis

After penetrating the airways, the virus enters the human cell through the Angiotensin 2 Converting Enzyme (ACE-2), which leads to an activation of immune system cells and production of inflammatory cytokines, contributing to an exacerbation of inflammatory effects, thus explaining lung damage, hyperinflammation and Severe Acute Respiratory Syndrome

(SARS). It is hypothesized that the target cell attacked by COVID-19 is the type II alveolus, which is important for the repair of alveolar damage, in addition to being involved in the reserve of regenerative cells and the production of surfactant[10].

Children have a lower number of ACE-2 receptors in the lower airways when compared to the upper airways that is why they have milder symptoms and a higher prevalence of upper airway involvement when compared to adults and/or elderly[11].

Main characteristics of covid-19 in pediatrics: symptoms

The main symptoms presented by children are mild respiratory distress, fever (37.7°C to 39.2°C), dry cough, sore throat, sneezing, nasal obstruction, rhinorrhea and fatigue. In addition, they may also present with gastrointestinal symptoms, such as discomfort, vomiting, abdominal pain and diarrhea[12]. As the condition progresses, they may present with dyspnea and cyanosis, which may progress to respiratory failure, which often resolves within three days. However, major complications such as septic shock, metabolic acidosis and coagulation dysfunction can occur, and are usually associated with an underlying condition[9,13,14].

Diagnosis in pediatrics

Diagnosis is based on the clinical picture, and confirmed through laboratory and imaging tests. Children should be investigated about having COVID-19 when they present two or more of the following symptoms: fever, cough, respiratory distress or tachypnea (RR>60rpm in patients under two months of life; RR>50rpm in patients between two and eleven months of life; and RR>40rpm in those between one and five years old)[13,15]. As for complementary tests, the gold standard for detecting SARS-CoV-2 nucleic acid is the test that assesses the real-time reverse transcriptase-polymerase chain reaction (RT-PCR). It is also possible to detect the virus in the blood, feces and urine and in the secretions of the lower or upper respiratory tract (swab or tracheal aspirate, nasopharynx, sputum and bronchoalveolar lavage)[5]. The blood count of these patients may be normal, or with leukopenia; Elevation of C-reactive protein (CRP) is frequent; Chest X-ray (RX) or Computed Tomography (CT) may show consolidations and/or ground-glass appearance. Chest CT of children is not as sensitive for the diagnosis of COVID-19, since approximately 20% with a confirmed diagnosis have normal CT scans[13,15]. Chest ultrasound is an exam that has been highlighted among imaging tests, as it can be performed at the bedside and can help in the detection of pulmonary alterations, especially pleural changes, pulmonary consolidations, and others[16].

Another important aspect is that about 5% of cases are asymptomatic. Usually, children who fit into severe cases are younger than three years of age and/or have previous comorbidities, such as cardiopulmonary and/or chronic neurological diseases. Children over ten years old and who do not have associated diseases fall into less severe categories[16].

It is important to emphasize that the differential diagnosis must be considered, as children may have COVID-19 and co-infection with other types of viruses such as Influenza, Parainfluenza, Adenovirus, Respiratory Syncytial Virus, Metapneumovirus; in addition to bacterial or Mycoplasma pneumonia[7].

Physical therapy approach in pediatrics

Upon approaching this population, prevention with the use of personal protective equipment (PPE) and contact precautions is extremely important[15]. During hospital screening, the patient and companion must receive a facemask and be placed in a separate area[18].

Table 1 shows the physical therapy approach according to the degree of severity, characteristics and intervention approaches. The approach will depend on the severity level presented by the child. Among the resources used in clinical practice for physical therapy management in pediatric patients diagnosed with COVID-19, oxygen supplementation, IMV, positioning and early mobilization stand out.

Despite discussions involving the use of NIV and HFNC, there is no consensus of information on the use of these resources in pediatrics. However, research in adults has shown that patients with a Partial Pressure of Oxygen and Inspired Oxygen Fraction (PaO_2/FiO_2) ratio greater than 200 benefit from the use of these resources. It is important to emphasize that these features can increase aerosolization, since in the HFNC and NIV the dispersion of gases is greater when compared to IMV, so if there is a need for use, the patient should preferably be in a room with negative pressure[17].

In cases of mild hypoxemia in which NIV is the resource of choice, the Helmet interface, is the most indicated due to lesser aerosolization, preferably with a double branch circuit, and when used, it must contain a Heat and Moisture Exchanger filter (HMEF) positioned between the mask and the Y-connector or a HEPA filter in the expiratory branch[17]. In patients with hypoxemic respiratory failure, the recommended period of NIV corresponds to 30 minutes, in cases of failure, early intubation is necessary[23].

In IMV, the same filters listed above can also be used, aiming to reduce the risk of aerosolization, in children it is important to monitor whether there will be an increase in the volume of dead space and airway resistance[29].

Another strategy used in clinical practice is the prone position, which should be started within the first 24 hours and/or 48 hours in pediatric patients with a $PaO_2/Fi0_2$ ratio <150. It should be kept for about 1-2 hours and performed 3 to 4 times a day. In the absence of results, this maneuver can be performed for 12 to 18 hours. If there is a 20% reduction in the PaO_2/FiO_2 ratio, after two consecutive attempts, the

Table 1. Physiotherapeutic approach according to the degree of severity.

Degree of Severity	Characteristics	Respiratory/Physical Therapy Approach
Asymptomatic	No respiratory symptoms and no radiological changes[19].	_____
Mild	Fever, cough, sore throat, fatigue, headache or myalgia, which happen together with upper respiratory infection and/or mild pneumonia[7,8].	- Oxygen monitoring, and if necessary use O_2 supplement[19]; Early mobilization: functional positioning, changes in decubitus position every 2h (day) and every 4h (night), sedestation on the chair (3X/day) and walking (2x/day)[20].
Moderate	Lower airway infection with cough, fever, wheezing in the pulmonary auscultation, respiratory discomfort and hypoxemia[21].	- Monitoring signs and symptoms and oxygen level through SpO2 (>94%) and/or arterial gas levels[19]; Raise the bed head 30° - 45°[22]; Oxygen-therapy: nasal catheter =PaO_2> 75mmHg, reservoir mask and HFNC=between 63 and 75 mmHg[16]; NIV in cases of mild hypoxemia, may be used by means of a Helmet with a filter (HMEF or HEPA), double branch circuit and a good interface seal[17]; Early mobilization: functional positions, changes in laying position every 2h (day) and every 4h (night),sensory-motor stimulation, bed sedestation (3x/day), and possible chair sedestation and walking[20].
Severe/Very Severe	Severe: LAW infection, cough, fever, signs of respiratory discomfort, gastrointestinal symptoms, there may be lack of appetite, dehydration and changes in the level of conscience [7]. Very Severe: LAW infection, progressive respiratory discomfort evolving to severe respiratory failure because of SARS, having refractory hypoxemia. There may be sepsis and septic shock contributing for the systemic dysfunction[7,15].	- Monitoring signs, symptoms and oxygenation by SpO_2 (>94%) and/or arterial gas levels[19]; NIV: PaO_2<63 mmHg consider intubation. Mode: A/C Upon pressure: Low CV=3 to 6mL/Kg, Plateau pressure<28cmH_2O, Driving pressure<15cmH_2O, RR= adjusted according to the minute ventilation and acid-base balance, PEEP adjusted to maintain PaO_2≥60 mmHg, start around 10 cmH_2O, pH tolerable up to 7.2 and FiO_2≤60%. Paramount to use HMEF or HEPA[19,22,24]; Aspiration: closed circuit when necessary[22]; Prone position: 1-2 h, 3 a 4x/day; in case of no results, increase to 12 to 18 h when PaO_2/FiO_2<150[25,26]; ECMO: VC=3 to 4ml/Kg; plateau pressure ≤28cmH_2O; Driving pressure≤10cmH_2O; FR=5/10rpm; FiO_2 on the ECMO membrane =100%; FiO_2 in the mechanical ventilator =50%; PEEP= 10/15cmH_2O[26]; Early mobilization: functional positioning and changes in laying down position every 2h (day) and every 4h (night), when in prolonged prone position, change position of ace and of upper and lower limbs every 2h[20]; Alveolar recruitment and respiratory measures: there is no consensus up to the present date[17,22,25,28].

SpO_2: Oxygen saturation; PaO2: Oxygen partial pressure in arterial blood; NIV: Non-invasive mechanical ventilation; HFNC: High-flow nasal cannula; LAW: Lower airways; SARS: Severe Acute Respiratory Syndrome; HMEF: Heat and Moisture Exchanger Filter; HEPA: High Efficiency Particulate Air Filter; IMV: Invasive mechanical ventilation; A/C: Assist-controlled; TV: Tidal volume; RR: Respiratory Rate; PEEP: Positive end-expiratory pressure; FiO2: Inspired oxygen fraction; h: Hours; ECMO: extracorporeal membrane oxygenation; Upper and lower limbs.

positioning should be interrupted[25,26].

After the acute phase, the use of mobilizations can be considered in order to stimulate the psychomotor development of children and prevent the repercussions generated by hospitalization, reduce the risk of muscle weakness acquired in the ICU, improve functional mobilization and typical development of the child. These protocols should be applied in all degrees of severity in pediatric patients with COVID-19, varying the approaches presented in Table 1, according to the clinical status presented. Critically ill patients are those intubated with no level of consciousness, PEEP>8cmH_2O and FiO2>60%, recent tracheostomy, acute neurological event, use of vasoactive drugs (except milrinone) or deep sedation. Moderate: those who are in intubation or tracheostomy responsive to touch or awake, with FiO_2 up to 60% and PEEP up to 8cmH2O, or in NIV with FiO2 >60%; and mild for those with a satisfactory level of consciousness in NIV of up to 60%, or under oxygen therapy[20].

The use of extracorporeal membrane oxygenation (ECMO) in more severe patients is also discussed[7]. This should be considered for this population, when the IMV, the prone position and other means were not effective to improve the respiratory failure. This therapy is indicated when the child has severe respiratory failure for more than 72 hours with the following clinical signs: PaO_2/FiO_2 ratio<50, for 3 hours and/or <80 for 6 hours, respiratory acidosis (pH<7.15), $PaCO_2$>60 mmHg, deficit in circulatory function, high doses of vasoactive drugs, continuous increase in lactic acid levels and/or other serious complications. It is contraindicated in cases where there is dependence on IMV for a period longer than two weeks, and cerebral bleeding[7,27].

Other resources are still being discussed by the scientific community, such as the use of high doses of surfactant,

high-frequency oscillatory ventilation, blood purification, use of nitric oxide and interferon spray in pediatrics[7].

Given the above, the relevance of the role of the physical therapist as a member of the multidisciplinary team in the treatment and recovery of pediatric patients infected with COVID-19 is evident, seeking to minimize the repercussions resulting from the disease[15].

CONCLUSION

Through this integrative review we found that the main characteristics of pediatric patients infected with COVID-19 are: mean age of onset of 7 years; main route of transmission is direct and/or indirect contact with respiratory droplets; physiopathogenesis distinct from adults due to a different immune response, thus generating a good prognosis; and symptoms ranging from dry cough, fever, sore throat, sneezing, rhinorrhea, fatigue, nasal obstruction, gastrointestinal symptoms, respiratory distress, dyspnea, cyanosis, septic shock, metabolic acidosis, and coagulation dysfunction.

Diagnosis is given by the clinical picture and categorized by severity: asymptomatic, mild, moderate, severe and very severe. Among the proposed approaches, the following stand out: oxygen therapy, invasive mechanical ventilation, keep the bed head elevated (30º-45º), prone position and early mobilization.

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