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Case Report

COVID-19 and Sickle Cell Disease in PICU: Case Report

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ABSTRACT

Sars-Cov 2 viral infection can cause an intense inflammatory reaction, hypoxemia and acute respiratory failure. The disease spreads more easily in chronic comorbidities, such as sickle cell anemia and overweight. Among the various professionals involved in the recovery of patients with Covid-19, the role of the physiotherapist stands out, not only for acting in the management of the disease but also for preventing and rehabilitating the respiratory deficiencies and the functional limitations caused by it. The present report aims to elucidate the multidisciplinary work carried out in the patient with overweight and sickle cell anemia during the period of hospitalization in the Pediatric Intensive Care Unit by Covid-19. This is an observational, longitudinal single-arm case report. The patient's medical data collection was carried out retrospectively through record, including anamnesis reports, physical examination, and multi-professional procedures used from admission to discharge, including anamnesis reports, physical examination, and multi-professional procedures used from admission to discharge. The present study is a rare case of pediatric Covid-19 with severe signs and symptoms. The treatment performed by the multidisciplinary team resulted in a favorable outcome since the beginning of hospitalization. Physiotherapy, including early mobilization and rehabilitation may help prevent or mitigate sequelae related to bed rest, thus improving physical function and outcomes and reducing length of stay by increasing ventilator free-days.

KEYWORDS

COVID-19; Child; Sickle Cell Disease; Physiotherapy; Pediatric Unit Intensive Care

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Introduction

Sars-Cov 2 viral infection can cause an intense inflammatory reaction, hypoxemia and acute respiratory failure. Depending on the clinical severity presented deficiency in respiratory muscle function and exercise tolerance may occur, causing difficulty in performing daily life activities that involve functional capacities (1).

The disease spreads more easily in chronic, autoimmune, and hematological comorbidities, such as sickle cell disease (SCD), which is a recessive hereditary hemolytic disease in which red blood cells, due to a mutation in the hemoglobin beta-chain gene. Reduction or obstruction of capillaries by sickle-shaped red blood cells can cause tissue hypoxia, worsening the circulatory situation and, more seriously, suffering tissue infarctions with necrosis and the formation of fibrosis. Therefore, patients with SCA are more likely to develop infectious conditions (2).

Childhood obesity is characterized as an accumulation of body fat compared to lean mass, providing negative health impacts. It is considered a metabolic and chronic disorder defined by the positive balance between consumption and energetic wear. The mechanisms by which obesity reduces microvascular reactivity in pre-puberty children is not yet well defined, but a defect in vascular relaxation can generate an inflammatory mechanism in smooth endothelial muscles, causing vasoconstrictions and possible tissue ischemia, especially in individuals with bad habits of life (3,4).

Among the various professionals involved in the recovery of patients with Covid-19, the role of the physiotherapist stands out, not only for acting in the management of the disease but also for preventing and rehabilitating the respiratory deficiencies and the functional limitations. This guarantees assistance with orotracheal intubation, support, and management of mechanical ventilation including weaning, removal of airway secretion, and changes in decubitus to improve the ventilation-perfusion ratio. The lenght of stay in PICU using continuous sedation and frequent use of neuromuscular blockers, cause global muscle weakness. The physiotherapist also acts in early functional rehabilitation, dealing with the low capacity to perform physical activities, in addition to physical inactivity, dyspnea during exercises, and low quality of life after hospital discharge (5,6).

The present study aims to report the multidisciplinary approach carried out in the critically ill patient with overweight and sickle cell anemia, during the period which he was admitted to the PICU by Covid-19.

Methodology

This case report carried out in the (PICU) of the Complexo Hospital de Clínicas da Universidade Federal do Paraná (CHC-UFPR), located in the city of Curitba-PR.

The data collection was performed through the patient's medical record, during his hospitalization period and after discharge from the PICU. Data were collected such as name, age, weight, height, origin, history of the previous disease and history of the current disease, imaging tests and laboratory tests.

The ventilatory data were recorded as Positive Airway Pressure (PAP), Positive End-Expiratory Pressure (PEEP), Inspired Oxygen Fraction (FiO_2), Mean Airway Pressure (MAP), Volume Tidal (VT: 4-8ml/kg predicted body weight), Plateau Pressure (PP), Drive Pressure (DP = plateau pressure - PEEP), PaO_2/FiO_2 Ratio, Oxygenation Index (OI = MAP x FiO_2 x 100/PaO_2). In addition to blood gas data such as pH, partial pressure of carbon dioxide in arterial blood (PCO_2), partial pressure of oxygen in the arterial blood (PaO_2) and blood bicarbonate values (BIC); and D-Dimer, PCR (C-reactive protein) and CK (creatine phosphokinase) laboratory and data.

The collection was made restrospectively after signing the Free and Informed Consent Term, approved by the research ethics committee (CAEE: 36760320.2.0000.0096) and signed by the parents.

Case Report

H. C. T. S., male, from of Toledo, of Paraná state, currently aged 12 years and 5 months, 152cm height and 58 kg, indicating overweight (BMI = 25.1). His underlying disease is SCD, making continuous use of folic acid (5mg/day) and hydroxyurea (500mg/day).

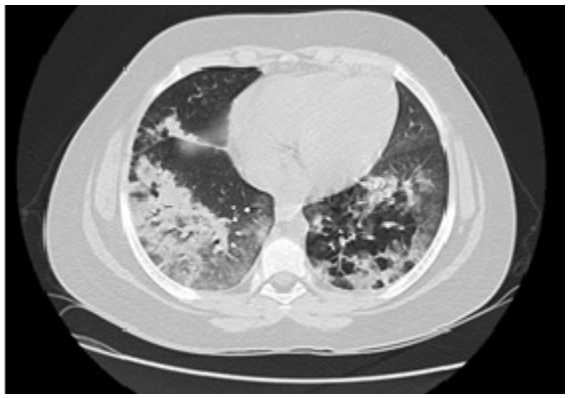
Seven days before admission, he had fever (38ºC) accompanied by complaints of body pain, chills, tremors, abdominal pain and vomiting. He recieved guidance and discharge to his home from the Emergency Care Unit in his city. Two days, he returned to the with abdominal pain, accompanied by weakness, tiredness, dyspnea, sweating, and was hospitalized.

On 06/21/2020 (D0), the patient was tested serologically with IgG and IgM positive for Sars-Cov 2. He also performed computed tomography (CT scan) (Figures 1 and 2). He collected the reverse-transcriptase polymerase chain reaction (PCR RT) that identified Covid-19 in the patient's nasal and oropharyngeal secretions.

The boy was intubated and transferred to the Hospital. He was sedated, pale, hydrated, and hypotensive, starting to use dobutamine. He had conjunctival hyperemia ("pink eye"). Parents were unable to be present in the transport and were not present at the time of admission.

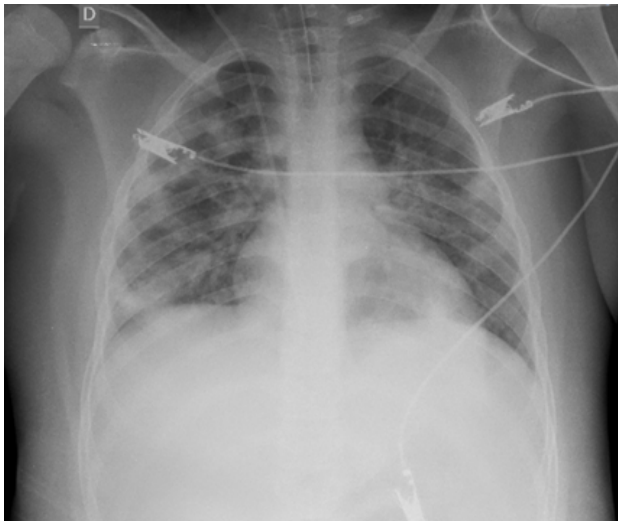
In laboratory tests, the CK (indicator of injury to the skeletal muscle creatinine) was 315, the C-reactive protein (CRP) was 13.0 and the D-Dimer, (analyzes hemostatic disorders related to thromboembolism and pro-coagulant effect), was 18.5. In gas analysis, pH = 7.33, PaO_2 = 96.6mmHg, PCO_2 = 26.3mmHg and HCO_3 = -2.6mEq/L.

The MV parameters were adjusted according to protective mechanical ventilation strategies (7,8). The ventilatory management



Figures 1 and 2: CT scan show highlights overperfused ground-glass pulmonary opacities, in addition to patchy consolidation of bilateral multifocal distribution with peripheral and posterior-inferior predominance. Such findings suggest viral pneumonia.

at the beginning of the pandemic, was based on classification of the respiratory involvement as ARDS-like. The patient was ventilated using Assisted Cotrolled Pressure (AC) with the parameters: PIP 28 cmH2O, PEEP 10 cmH2O, FiO2 60%, 20 respiratory rate (RR), volume tidal (VT: 298 ml) according to the patient's predicted body weight (49 kg). The admission PaO_2/FiO_2 ratio was of 160 and OI of 7.28 (ARDS classified as moderate). The admission X-Ray showed ill-defined opacities in the lower two thirds of the lungs, predominantly on the right (Figure 3).



The patient while on MV required sedation, analgesia and neuromuscular block. Besides, anticoagulant, antibiotics, and drugs for continuous use to treat the underlying disease (Table 1). He received a diet on D1 with norm caloric and normoproteic enteral formula in a closed system (original Fresulim).

The chest physiotherapy was bronchial hygiene, endotracheal suctioning, lung reexpansion techniques, manual mobilization, and respiratory muscle training. Besides the musculoskeletal proprioceptive stimulation and exercise training, were performed frequent changes in decubitus and therapeutic positions during the patient's immobility.

	D0	D1	D5	D9	D15
Azithromycin	x	x			
Cefiatrexone	x	x	x	x	
Dexamethasone	x	x	x	x	
Oseltamivir	x	x			
Dobutamine	x	x	x	x	
Tobramycin				x	
Omeprazole	x	x	x	x	x
Clonidine				x	x
Midazolam	x	x	x	x	x
Fentanyl	x	x	x	x	x
Precedex	x	x	x		
Vecuronium	x	x	x		

Table 1: Drugs received by the patient during the MV.
Source: author. Legend: D0 - hospitalization day. D1-D15 – days of hospitalization.

During hospitalization, calculations of static compliance, OI, PaO_2/FiO_2 ratio, and drive pressure were of great importance for the daily monitoring of pulmonary mechanics.

After 10 days from the start of hospitalization, it was possible to pass his A/C ventilation mode to intermittent mandatory ventilation synchronized with support pressure (SIMV + PS). One new CT scan was performed on 06/27, (Figure 4). The MV parameters and blood gas analysis from the date of admission to the date of extubation are described in Table 2.

The patient was agitated at D9, during sedation weaning, and led a unplanned extubation. The patient evolved with inspiratory muscle effort, tachypnea and dyspnea, laryngeal stridor with partial laryngotracheal obstruction. The team tried to use non-invasive ventilation (NIV) and failed, being intubated 24 hours after extubation.

Ventilation	D0	D1	D5	D9	D15
FiO_2	60%	40%	40%	40%	25%
Volume tidal ml/kg	9,1	7,1	8,3	8,1	7,6
Plateau Pressure cmH_2O	26	24	24	24	18
Drive Pressure cmH_2O	16	14	14	14	10
PEEP cmH_2O	10	10	10	10	8
Static Compliance ml/ cmH_2O	33	25	38,8	31	37,2
Gasometry	D0	D1	D5	D9	D15
pH	7,3	7,4	7,43	7,5	7,3
PCO_2 mmHg	44	37	47,4	44	43
PaO_2 mmHg	97	86	73,3	91	90
HCO_3 mEq/L	23	23	30,8	31	31
PaO_2/FiO_2	160	216	183	227	215
OI %	9,9	7,4	7,09	6,8	3

Table 2: Evolution of MV parameters and blood gas analysis.

realization of a diaphragmatic breathing pattern with the proprioception of the muscle using manual stimulation to promote the recruitment of type I fibers of the diaphragm (slow contraction) to improve muscular performance.

The patient maintained chest expansion exercises, such as active inspiration patterns followed by apnea after inspiration (sustained inspiration for 3 seconds) with the objective of alveolar recruitment and improvement of VT.

The performance of breathing exercises based on lung volumes and capacities, contributed to the patient's greater independence in the control of his dyspnea and the recovery of his volumes and capacities, reduced by restrictive lung disease. Chest physiotherapy allowed the resolution of small areas of atelectasis that persisted even after the removal of MV. Regarding home rehabilitation phase, the multidisciplinary team provided verbal and practical guidance to the patient and the family member, so that their daily life functions could be fully recovered, even without intensive monitoring.

Figures 4 and 5: The second CT scan shows areas of attenuation of multifocal ground glass, associated with small foci of consolidation. Areas and atelectasis in the posterior regions of the lungs, more evident in the lower lobes, with signs of associated air trapping.

During weaning from MV until extubation, physiotherapy treatment focused on respiratory autonomy associated with neuromuscular activity. Kinesiotherapy started to be active-assisted in bed. About 24 hours after extubation, the patient became more independent. It was possible to carry out transfers in bed, bedside orthostasis training and gait training. Performed muscle strengthening exercises, balance training. It was also possible to perform active-resisted exercises for upper and lower limbs with the help of dumbbells and a cycle ergometer.

After 5 days of reintubation (D15), the spontaneous breathing trial (SBT) was chosen, the indicators showed greater chances of success. It remained stable with SpO_2 = 95%, RR = 20, nasal catheter at 3 L/min by oxygen (FiO_2 = 32%). The patient maintained adequate respiratory and ventilatory patterns (SpO_2 of 98% and 13 RR) without oxygen supply.

Chest physiotherapy after extubation aimed to improve exercise tolerance and reduce the persistent oxygen requirement. The

The laboratory tests showed a CRP value of 1.72 and a D-Dimer of 1.01. The patient remained hospitalized at PICU from admission untill hospital discharge (25 days), due to the standart isolation measures. After that, he was able to return to his daily activities.

Discussion

The present report represents a rare case of pediatric Covid-19 with severe manifestation of signs and symptoms, The disease was classified as severe pneumonia with OI = 9.91. The pediatric population affected by Covid-19, 2.1% have severe symptoms and only 1.2% are critical (9,10).

Children infected with Covid-19 may be asymptomatic or symptomatic with fever, dry cough, and fatigue, as well as upper respiratory symptoms. The need for invasive ventilatory support only happened in critical cases (9,11).

Children and adolescents often have respiratory diseases that can

lead to reduced oxygenation. Furthermore, in SCD there is an vicious cycle between hypoxemia and red blood cell deformation, leading to vaso-occlusive crises with the risk of thromboembolic accidents (12).

The use of OI and the PaO_2/FiO_2 ratio in pediatric patients is a fundamental tool in the management of oxygenation in children. Daily monitoring of ventilatory parameters and respiratory mechanics recommended to avoid injury associated with MV. By calculating the predicted weight, it was possible to ventilate the patient safely, performing a VT of 6 to 8 ml/kg, low PAP in order to maintain P plato up to 28 cm H_2O, and control of pulmonary distention pressure (drive pressure) below 15 cmH_2O (13-16).

The need to titrate PEEP individually is currently the best way to recruit and stabilize alveolar units and minimize lung injury induced by MV. The ideal PEEP titration can avoid atelectrauma and alveolar hyperdistension, suggested for cases of severe and moderate ARDS, as is the case in the present report. The current recommendation suggests a prior recruitment maneuver followed by decremental PEEP, selecting the best static compliance of the respiratory system, always estimating the lowest drive pressure (7,15-17).

Physiotherapy has proven effective for improving long-term physical function among PICU survivors. The therapies applied in the present report ensured the viability of the respiratory system during the period of intubation and in the phase of inability to breathe independently and to protect its airways. The literature suggests that physiotherapy maneuvers result in significant changes in respiratory function. The patient's favorable condition was due to these resources, since he did not present any type of infection or pneumonia associated with mechanical ventilation while hospitalized (18,19).

Chest physiotherapy during MV is feasible and safe to improve patient performance. During MV like mucus clearance and alveolar recruitment maneuvers are commonly applied in clinical practice. Sputum production was reported in about 34% of Covid-19 patients. Thus suggesting that, by promoting mucus clearance during mechanical ventilation, early physiotherapy interventions (such as subglottic secretion drainage, postural hygiene, and ventilator hyperinflation) may produce beneficial effects (20,21).

The chest physiotherapy process in critically ill Covid-19 patients should be carefully organized, considering the high risk of aerosol generation. Health care workers should begin the process only after donning appropriate personal protective equipment and, if possible, should organize the procedure in a negative-pressure room with an antechamber to minimize exposure and the patient was electively extubated (20).

Physiotherapy for critical patients, is based on a multisystem approach, like musculoskeletal rehabilitation, in order to reduce the incidence of complications, encourage weaning from mechanical ventilation, and facilitate recovery of functional autonomy (21).

The physiotherapist's role in the acute phase of the disease is not restricted to the respiratory system, exercises and mobilizations, but also minimize musculoskeletal deficits resulting from prolonged immobilization. Moreover, one of the keys therapeutic strategies for these patients has been the early use of corticosteroids, which is another important risk factor implicated in PICU acquired weakness. Passive early motor mobilization has stood out a lot in the treatment of patients with Covid-19, and aims to maintain muscle tropism, stretching, joint mobility and especially the functional capacity to perform basic activities of daily living (22-24).

Conclusion

The treatment carried out by the physiotherapy together with multidisciplinary team for this critical patient resulted in favorable outcomes. Through the safe management of drugs, the protective strategy of MV, the success of extubation and the process functional recovery since the beginning of hospitalization until hospital discharge.

Physiotherapy, including rehabilitation may help to prevent or mitigate sequelae related to bed rest, thus improving physical function and outcomes and reducing length of stay by increasing ventilator free-days.

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