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Case Report

The Impact of Physiotherapy on Motor Function in a Child Recovering from Human Coronavirus NL63: A Case Report

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Abstract

Backgrounds: This case report aims to investigate potential neurological complications in children following Human Coronavirus NL63 (HCoV-NL63) infection and evaluate the effectiveness of 12-week physiotherapy intervention in improving motor function in this child. **Methods:** This case study examines a four-year-old male patient with multiple health dysfunctions following an HCoV-NL63 infection. A 12-week rehabilitation program including whole body vibration, lower extremities strengthening exercise, stairs climbing, balance exercise, and obstacles course was performed. The evaluation included the Pediatric Balance Scale (PBS), the Denver Developmental Screening Test (DDST), and the 10-Meter Walking Test (10MWT) to assess motor abilities and walking speed. **Results:** The participant demonstrated clinically meaningful improvement in motor function. The PBS score increased from 33 at baseline to 49 at 12 weeks. Walking speed increased from 0.56 meters/second at baseline to 1.43 meters/second. The DDST revealed improvement in fine motor skills such as copying a circle and drawing a person with three body parts **Conclusions:** This case report demonstrates that a 12-week physiotherapy program can lead to substantial improvements in motor function, including balance and walking speed, in a child with developmental delays following a severe HCoV-NL63 infection. However, the study also highlights the broader neurological and developmental populations. While respiratory symptoms are typically the focus of HCoV-NL63 treatment, this case report suggests that clinician should also consider potential long-term neurological effects, especially in severe cases. The child's history of seizures and global developmental delay points to the need for more research into the virus's impact on brain function and development.

Keywords: Case Report, Coronavirus, Hcov-Nl63, Developmental Delay, Pediatric.

Introduction

Human Coronaviruses (HCoV) are a large family of viruses that can cause illness in both animals and humans (Peiris, 2012). They are named for the crown-like spikes on their surface, which are visible under a microscope (Chathappady House, Palissery, & Sebastian, 2021). While many coronaviruses are known to infect animals, several have adapted to infect humans, causing a range of illnesses from the common cold to more severe respiratory diseases (Peiris, 2012).

There are seven known human coronaviruses. Four of these, HCoV-229E, HCoV-OC43, HCoV-HKU1, and HCoV-NL63, typically cause mild to moderate upper respiratory infections resembling the common cold. In contrast, the other three - SARS-CoV, MERS-CoV, and SARS-CoV-2 - have caused significant outbreaks with more severe symptoms (Liu, Liang, & Fung, 2021).

HCoV-NL63 was discovered in the Netherlands in 2004 (Van Der Hoek et al., 2004). HCoV-NL63 is a common cause of upper respiratory tract infections, particularly in young children and the elderly (Pyrc, Jebbink, Berkhout, & Van der Hoek, 2004). While typically associated with mild symptoms such as runny nose, cough, and sore throat, HCoV-NL63 can also lead to more severe lower respiratory tract infections, such as bronchiolitis and pneumonia, in some cases (Fouchier et al., 2004).

It primarily spreads through respiratory droplets expelled when an infected individual coughs or sneezes. It can also be transmitted through direct contact or by touching contaminated surfaces (Chiu et al., 2005). Symptoms of HCoV-NL63 infection are typically mild and resemble those of the common cold, including runny nose, cough, sore throat, sneezing, headache, body aches, and occasionally fever (Sung et al., 2010).

This disease is a common occurrence worldwide. It has been detected in various populations, with a higher prevalence observed in children, the elderly, and immunocompromised individuals. The virus exhibits a seasonal pattern, with peak infection rates occurring during winter months in temperate climates. Studies have estimated that HCoV-NL63 accounts for approximately 1-9% of respiratory tract infections in children (Van Der Hoek et al., 2010).

Currently, there is no specific antiviral treatment available for HCoV-NL63 infections. Treatment primarily focuses on managing symptoms. This typically involves over-the-counter medications to alleviate fever, pain, and congestion. Adequate rest, staying hydrated, and using humidifiers can also help alleviate symptoms. However, in severe cases, hospitalization may be necessary for supportive care, such as oxygen therapy or intravenous fluids (Paredes-Amaya, Matta-Cortes, & Zea-Vera, 2022; Pyrc et al., 2006).

HCoV-NL63 typically causes mild to moderate illness. While it can lead to more severe lower respiratory tract infections in certain groups, such as young children, the elderly, and immunocompromised individuals, it's generally less severe than other coronaviruses like SARS-CoV-2 (Sung et al., 2010). However, co-infection with other respiratory viruses can exacerbate symptoms and increase the risk of complications (Moës et al., 2005).

The complications are primarily observed in high-risk groups. While most infections lead to mild symptoms, severe cases can progress to lower respiratory tract infections such as bronchiolitis and pneumonia, necessitating hospitalization (Sung et al., 2010). Weakened immunity due to HCoV-NL63 infection can also increase susceptibility to secondary infections including bacterial pneumonia, ear infections, and sinus infections. These infections often develop after the initial viral illness has begun to subside (Moës et al., 2005).

While HCoV-NL63 primarily affects the respiratory system, emerging evidence suggests potential neurological involvement. Although most cases result in mild, self-limiting illness, severe infections, particularly in vulnerable populations

like young children, can lead to complications beyond the respiratory tract. In severe cases, HCoV-NL63 infection can lead to complications such as hypoxia, systemic inflammation, and even encephalitis (Almqvist et al., 2020). Hypoxia can occur during severe respiratory illness, particularly in cases requiring intensive care and mechanical ventilation. This oxygen deprivation can have profound effects on the developing brain (Piešová & Mach, 2020).

Systemic inflammation, a widespread immune response triggered by the infection, can also contribute to neurological complications. Inflammatory mediators released during this response can cross the blood-brain barrier, potentially leading to neuroinflammation, which can disrupt brain function and contribute to neurological impairments. These factors, including hypoxia and systemic inflammation, can have significant consequences for the developing brain. Potential complications may include cognitive impairments, motor impairments, behavioral and emotional problems, and seizures (Franjoine, Gunther, & Taylor, 2003).

It is important to note that the specific neurological manifestations can vary significantly between individuals and may not always be readily apparent in the immediate consequences of the infection (Franjoine et al., 2010). Long-term follow-up is crucial to assess the full spectrum of neurological and developmental outcomes in children who have experienced severe HCoV-NL63 infections (Yi, Hwang, Kim, & Kwon, 2012).

It's crucial to note that research on the neurological implications of HCoV-NL63, particularly in children, is still in its early stages. A comprehensive understanding of the virus's long-term impact on the brain remains elusive. Therefore, this case study aims to identify potential neurological complications arising from HCoV-NL63 infection in children. Furthermore, the effectiveness of early physiotherapy intervention in addressing these complications will be investigated.

Methodology

Study Design

This study was based on a Case Study Design.

Case Description

A four-year-old male with a pre-existing history of seizures and global developmental delay, and segmental facial vitiligo presented with lower limb weakness and gait abnormalities.

Birth and Neonatal History

Born full-term via cesarean section on November 25, 2018, weighing 3.2 kg. Briefly admitted to the neonatal intensive care unit for transient tachypnea.

Medical History

In March 2019, the participant experienced a severe HCoV-NL63 infection characterized by recurrent cyanosis and apnea, requiring intensive care and mechanical ventilation. This severe respiratory event may have contributed to hypoxia and potential neurological complications.

Developmental History

Delayed motor milestones were observed, with independent walking achieved at two years and three months.

Developmental Assessment

Evaluation conducted in August and October 2023 revealed a range of developmental challenges. Upper limb and oral muscle weakness affected grasp and reach, and while the patient was independent with self-care activities, assistance was needed with dressing and bathing. Difficulty following commands and lower limb muscle weakness were also observed, despite good static and dynamic balance. Although the patient could walk and climb stairs independently, jumping was limited.

This patient presented with a complex medical history, including pre-existing neurodevelopmental

disorders. The severe HCoV-NL63 infection, requiring intensive care and mechanical ventilation, may have contributed to respiratory complications and potential neurological sequelae, potentially exacerbating existing developmental challenges. The observed lower limb weakness, gait abnormalities, and delayed motor development may be multifactorial, with contributions from pre-existing conditions, the severe HCoV-NL63 infection, and potential neurological complications.

Physical Therapy Intervention

Participant received a rehabilitation program for 12 weeks, 3 times per week. The rehabilitation focuses on improving overall physical function and lower extremity strength including:

Whole-body vibration: This technique involves standing on a vibrating platform to stimulate muscles, improve balance, and increase bone density.

Lower extremities strengthening exercises: Activities like transitioning from kneeling to standing and sitting to standing target specific muscle groups in the legs, enhancing strength and stability.

Stair climbing: This exercise challenges balance, coordination, and lower extremities strength while simulating real-life activities.

Balance exercise: Improving balance is crucial for preventing falls and enhancing overall stability.

Obstacle course: This activity addresses functional limitations by incorporating various challenges that mimic everyday tasks, promoting independence and confidence.

Outcome Measures

The study's primary focus was on functional outcomes and developmental progress. To assess these aspects, the Pediatric Balance Scale (PBS) was used to measure functional balance, the Denver Developmental Screening Test (DDST) was used to assess developmental improvement, and 10-meter walking test (10MWT) to assess the speed of walking. Participant was evaluated using these three tools at three time points: baseline, four weeks after the intervention, and twelve weeks after the intervention.

Pediatric Balance Scale (PBS)

The Pediatric Balance Scale (PBS) is a modified version of the Berg Balance Scale adapted for children aged 5 to 15 with mild to moderate motor impairments (Franjoine, Darr, Held, Kott, & Young, 2010). It consists of 14 items assessing functional balance activities (Chen et al., 2013). Studies have demonstrated high reliability and validity of the PBS in evaluating balance in children with cerebral palsy (Yi et al., 2012; Watson, 2002). This scale is recommended for assessing functional balance due to its simplicity, practicality, and ability to provide valuable information within a short assessment time (Chen et al., 2013).

The Denver Developmental Screening Test (DDST)

The Denver Developmental Screening Test (DDST) is used to assess children from birth to six years old in four key areas: personal-social, fine motor-adaptive, language, and gross motor skills (Santos et al., 2022). It helps identify potential developmental delays, prompting further evaluation if necessary (Cadman et al., 1984). It has shown good inter-rater reliability, indicating consistency among different examiners. Studies have reported moderate to strong concurrent validity with other developmental assessment tools. It's essential to consider these factors when interpreting DDST results and to use it in conjunction with other assessment methods for a comprehensive evaluation (Watson, 2002).

The 10-Meter Walk Test

The 10-Meter Walk Test (10MWT) is a simple and effective tool designed to evaluate a child's walking speed and functional mobility. It involves walking a

distance of 10 meters at a comfortable or fast pace while measuring the time taken to complete the walk (de Baptista et al., 2020). Additionally, the 10MWT can help identify abnormalities or limitations in walking patterns (Wen et al., 2022). This test is specifically designed for children and adolescents aged 2 to 17 years (Wen et al., 2022). If a child's walking speed is significantly slower than expected for their age, it may indicate a delay in motor development or an underlying health condition (Fatima et al., 2014). The 10MWT has been proven to be a reliable and valid tool for assessing walking speed and functional mobility in children. Studies have consistently shown its accuracy and consistency in pediatric populations (Gupta, Pande, & Swati, 2022).

Data Analysis

Administrative and Ethical Considerations

The study received ethical approval from the Institutional Review Board (IRB) at King Abdullah International Medical Research Center (KAIMRC), with reference number 0000037324. Informed consent was obtained in writing from the participant.

Results

Functional Balance

PBS was assessed at three time points: baseline, 4-weeks, and 12-weeks post-intervention. The participant demonstrated a significant improvement in overall balance function, with a total PBS score increasing from 33 at baseline to 49 at 12 weeks. The mean score at baseline was 2.36 with a standard deviation of 1.50, while at 12 weeks, the mean score improved to 3.50 with a standard deviation of 1.09. this suggests a reduction in the variability in performance across the different balance items at 12-week assessment. The results are presented in Table 1.

Motor Development

The participant's motor development was evaluated using the DDST at three time points: baseline, 4-weeks, and 12-weeks post-intervention. The results of the DDST assessment are presented in Figure 1. Although the child's functional age was considered to be younger than his chronological age, the results indicate that the child's development has improved in all domains. While the results of the longitudinal assessment showed similar results, there are a few areas where the child has made progress. In Fine motor domain, the child has improved in his ability to copy a circle and draw a person with three body parts. Moreover, in language domain, the child has improved in his ability to copy a circle and draw a person with three body parts. However, the child has not made substantial progress in his gross motor skills or personal-social development.

Table 1. illustrates Scores of each item in Pediatric Balance Scale

Items in Pediatric Balance Scale	Baseline	4 weeks	12 weeks
Sitting to Standing	4	4	4
Standing to sitting	4	4	4
Transfers	4	4	4
Standing unsupported	4	4	4
Sitting with back unsupported and feet supported	4	4	4
Standing unsupported with eyes closed	2	3	4
Standing unsupported with feet together	1	2	4
Standing unsupported one foot in front	1	2	3
Standing on one leg	0	0	0
Turn 360 degrees	3	3	4
Turning to look behind left & right shoulders while standing still	3	4	4

Pick up object from the floor from a standing position	1	3	4
Placing alternate foot on step stool while standing unsupported	1	2	3
Reaching forward with outstretched arm while standing	1	1	3
Total score	33/56	40/56	49/56
Mean	2.36	2.86	3.5
Standard deviation	1.5	1.29	1.09

Walking Speed

The 10-meter walk test (10MWT) was used to assess the participant's walking speed at three time points: baseline, 4-weeks, and 12-weeks post-intervention. At baseline, the participant walked 10 meters in 18 seconds, resulting in a speed of approximately 0.56 meters per second. After four weeks, the participant's speed increased to 0.83 meters per second. At the twelve-week follow-up, the participant's speed further improved to 1.43 meters per second. The mean walking speed across the three time points was 0.954 meters per second with a standard deviation of 0.45. Overall, participant demonstrated a significant improvement in walking speed over the course of the intervention. The results of the 10MWT are summarized in Table 2.

Table 2: illustrate the Scores of 10-meter walking test (10MWT) and the calculated participant's speed.

Timeline	Score (sec)	Speed (m/sec)
Baseline	18	0.56
4 weeks	12	0.83
12 weeks	7	1.43
Mean	12.33	0.94
SD	5.51	0.45

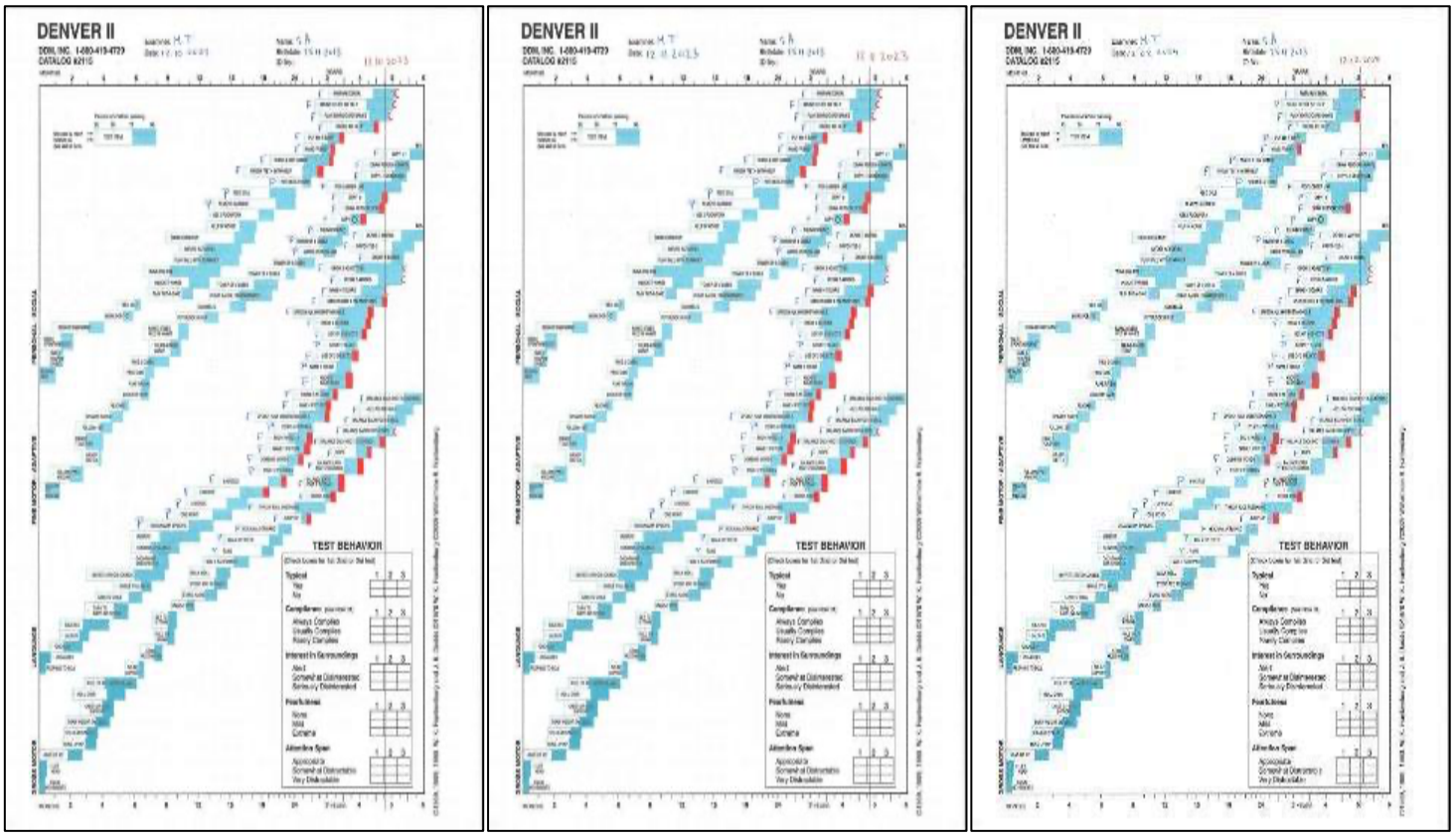

Figure 1: Longitudinal Assessment of Motor Development using DDST (12/10/23, 12/11/23,

Discussion

A notable improvement was observed in PBS score, indicating a positive prognosis for balance development. This improvement was seen after analyzing cases to determine the impact of coronavirus cases and physiotherapy roles management. The PBS score increased noticeably from 33 total points to 49 in 12 weeks, especially in tasks involving weight-bearing positions.

This case study highlights the complex relationship between HCoV-NL63 infection, neurological complications, and motor development in a pediatric patient. The patient, a four-year-old boy with a history of developmental delay and seizures, presented with lower limb weakness and gait abnormalities following an HCoV-NL63 infection. Over the 12-week rehabilitation program, substantial improvements in balance, walking speed, and fine motor skills were observed, emphasizing the effectiveness of physiotherapy intervention. However, several critical insights can be drawn from these findings.

HCoV-NL63 is primarily known for causing mild to moderate respiratory infections, but this case suggests that severe infections, especially in young children, can lead to developmental setbacks. While the virus predominantly affects the respiratory system, its potential to indirectly cause neurological complications, especially through hypoxia, should not be overlooked. In this case, the child experienced a serious infection in 2019 that required mechanical ventilation and intensive care, possibly contributing to delayed motor development. This aligns with research indicating that severe respiratory infections in children can impair brain development due to hypoxia and systemic inflammation (Almqvist et al., 2020).

The delayed motor milestones, including the patient's late onset of independent walking at 27 months, support the notion that respiratory infections during critical stages of development can have lasting effects on motor function. Although the patient improved after the rehabilitation program, his functional age was still behind his chronological age. This underlines the need for developmental assessments in children who experience severe viral infections, particularly HCoV-NL63. The study by Gupta et al. (2022) emphasized the importance of early identification of severe cases to ensure timely and appropriate treatment for better outcomes.

The results of the study indicate that a targeted physiotherapy program can significantly improve motor outcomes in children with developmental delays exacerbated by viral infections. The interventions, which included lower extremity exercises, stair climbing, and balance training, effectively enhanced the patient's physical function. The marked improvement in walking speed, increasing from 0.56 meters per second at baseline to 1.43 meters per second after twelve weeks, suggests that consistent physical therapy can substantially improve lower limb strength and functional mobility. Several studies have demonstrated the effectiveness of physiotherapy in improving functional mobility for children with developmental delay (King et al., 2002; Conroy & Logan, 2014).

Previous studies have demonstrated the benefits of physical therapy for children with motor impairments, and this case further supports those findings (Chen et al., 2013). While the patient still had deficits in some areas, such as gross motor skills and personal-social development, the progress in balance and walking speed indicates that rehabilitation can address functional limitations and improve quality of life. This aligns with the findings of Li, X. et al., (2024), who also reported that rehabilitation can address functional limitations and improve quality of life. The improvements in fine motor skills, including the ability to copy a circle and draw a person with three body parts, also highlight the importance of a multidisciplinary approach that includes both physical and developmental interventions.

Neurological Implications of HCoV-NL63 Infection

Although there is limited research on the

neurological effects of HCoV-NL63, this case suggests the need for further investigation. The patient's history of seizures and developmental delays raises the question of whether HCoV-NL63, or the associated respiratory distress and hypoxia, played a role in the development of these conditions. Research has shown that severe viral infections in early childhood can have long-term neurological consequences, particularly if oxygen deprivation occurs (Piešová & Mach, 2020). In this case, while the patient did not present with overt neurological symptoms during the study, his history of seizures and global developmental delay suggests that HCoV-NL63 may have indirectly contributed to these issues.

Further research is needed to understand the long-term impact of HCoV-NL63 infections on the brain, especially in vulnerable populations such as children. While respiratory symptoms are typically the primary concern with HCoV-NL63, this case underscores the importance of considering potential neurological complications, especially when the infection is severe.

One limitation of this case study is the small sample size, as it focused on a single patient. As a result, the findings may not be generalizable to all children with HCoV-NL63 infections. Additionally, the study did not explore other factors that could have contributed to the patient's developmental delays, such as genetic predispositions or environmental influences. Future studies should include larger cohorts to determine whether the patterns observed in this case are consistent across a broader population of children who experience severe HCoV-NL63 infections.

Moreover, while the patient demonstrated improvement in functional balance and motor skills, other developmental domains, such as personal-social interactions, showed limited progress. This suggests that rehabilitation programs should adopt a more holistic approach, incorporating interventions that address not only physical deficits but also cognitive and social development. Further research should also examine the long-term outcomes of children who receive physiotherapy intervention after severe viral infections to determine whether these improvements are sustained over time.

Conclusion

This case study underscores the significant impact that severe HCoV-NL63 infections can have on the motor and developmental outcomes of young children, particularly those with pre-existing conditions like developmental delay and seizures. Study findings suggest that targeted physiotherapy interventions can play a pivotal role in improving motor function, balance, and fine motor skills in affected children. However, the study also highlights the broader neurological and developmental challenges associated with HCoV-NL63, particularly n vulnerable populations. While respiratory symptoms are typically the focus of CoV-NL63 treatment, this case report suggests that clinicians should also consider potential long-term neurological effects, especially in severe cases. The child's history of seizures and global developmental delay points to the need for more research into the virus's impact on brain function and development.

Author Contributions

All authors significantly contributed to the work reported, including conception, study design, execution, data acquisition, analysis, and interpretation. They actively participated in drafting, revising, or critically reviewing the manuscript, provided final approval of the version to be published, agreed on the journal submission, and accepted accountability for all aspects of the work.

Data Availability Statement

The authors will transparently provide the primary data underpinning the findings or conclusions of this article, without any unjustified reluctance. If need from editorial team.

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Conflicts of Interest

The authors declare no potential conflicts of interest related to the research, writing, or publication of this work

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