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Telemonitoring of chronic lung disease patients assisted by the pulmonary rehabilitation program in the COVID-19 pandemic

Telemonitoramento de pneumopatas crônicos assistidos por programa de reabilitação pulmonar na pandemia da COVID-19

Telemonitorización de neumópatas crónicos asistidos por programa de rehabilitación pulmonar en la pandemia de COVID-19

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ABSTRACT

Objective: To assess exercise capacity in chronic lung disease patients assisted by a Pulmonary Rehabilitation Program (PRP) during the COVID-19 pandemic after a home exercise telemonitoring strategy. **Methods:** A quantitative observational study was carried out from March to November 2020 with chronic lung disease patients treated in a PRP of a public hospital through telemonitoring. Sociodemographic and clinical data, exercise capacity as measured by the 6-minute walk test (6MWT) and lower limb incremental and endurance were analyzed before starting PRP and after the telemonitoring period. The study followed all ethical precepts and was approved by the ethics committee. **Results:** 22 individuals were included in the study, but only 11 underwent the final assessment. The majority were female (73%), with a mean age of 55 ± 11 years, incomplete primary education (46%) and diagnosed with Chronic Obstructive Pulmonary Disease (COPD) (37%). There was no change in the 6MWT and LL incremental results (p>0.05). However, there was an increase in the LL endurance test time, going from 362 ± 209 seconds to 1.142 ± 989 seconds (p=0.003). **Conclusion:** Telemonitoring contributed to gains in submaximal exercise capacity in chronic lung disease patients following PRP when face-to-face monitoring was no longer possible.

Descriptors: Telemonitoring; Rehabilitation; Respiratory diseases; Health education.

RESUMO

Objetivo: *Avaliar a capacidade de exercício de pneumopatas crônicos assistidos por um Programa de Reabilitação Pulmonar (PRP) na pandemia da COVID-19, após estratégia de telemonitoramento de exercícios físicos domiciliares.* ***Métodos*****:** *Estudo observacional, de abordagem quantitativa, realizado de março a novembro de 2020, com pneumopatas crônicos atendidos em um PRP de um hospital público através do telemonitoramento. Foram analisados dados sociodemográficos e clínicos, capacidade*

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de exercício pelo teste da caminhada de 6 minutos (TC6), incremental e de endurance de membros inferiores, antes de iniciar o PRP e após o período de telemonitoramento. O estudo seguiu todos os preceitos éticos e foi aprovado por comitê de ética. ***Resultados:*** *22 indivíduos foram incluídos no estudo, mas somente 11 realizaram a avaliação final. A maioria do sexo feminino (73%), com média de idade de 55 ± 11 anos, ensino fundamental incompleto (46%) e com diagnóstico de Doença Pulmonar Obstrutiva Crônica (DPOC) (37%). Não houve mudança nos resultados do TC6 e do incremental de MMII (p>0,05). Contudo, houve um aumento no tempo do teste de endurance de MMII, passando de 362 ± 209 segundos para 1.142 ± 989 segundos (p=0,003).* ***Conclusão:*** *O telemonitoriamento contribuiu para ganhos na capacidade submáxima de exercício, em pneumopatas crônicos de um PRP, quando o acompanhamento presencial não foi mais possível.*

Descritores: *Telemonitoramento; Reabilitação; Doenças Respiratórias; Educação em saúde.*

RESUMEN

Objetivo: *Evaluar la capacidad de ejercicio de Neumópatas crónicos asistidos por un Programa de Rehabilitación Pulmonar (PRP) en la pandemia de COVID-19, después de estrategia de Telemonitorización de ejercicios físicos domiciliarios.* ***Métodos:*** *Estudio observacional, de enfoque cuantitativo, realizado de marzo a noviembre de 2020, con Neumópatas crónicos atendidos en un PRP de un hospital público por medio de Telemonitorización. Fueron analizados datos sociodemográficos y clínicos, capacidad de ejercicio por test de caminada de 6 minutos (TC6), incremental y de resistencia de miembros inferiores, antes de iniciar el PRP y después del período de telemonitorización. El estudio siguió todos los preceptos éticos y fue aprobado por el comité de ética.* ***Resultados:*** *22 individuos fueron incluidos en el estudio, pero solamente 11 realizaron la evaluación final. La mayoría del sexo femenino (73%), con media de edad de 55 ± 11 años, enseñanza básica incompleta (46%) y con diagnóstico de Enfermedad Pulmonar Obstructiva Crónica (DPOC) (37%). No hubo cambio en los resultados TC6 y del incremental de MMII (p>0,05). Sin embargo, hubo un incremento en el tiempo del test de resistencia de MMII, pasando de 362 ± 209 segundos para 1.142 ± 989 segundos (p=0,003).* ***Conclusión:*** *La telemonitorización contribuyó para ganancias en la capacidad submáxima de ejercicio, en Neumópatas crónicos de un PRP, cuando el acompañamiento presencial ya no fue posible.*

Descriptores: *Telemonitorización, Rehabilitación, Enfermedades respiratorias, Educación en salud.*

INTRODUCTION

In February 2020, the COVID-19 pandemic settled in Brazil causing numerous implications for the health system and leading the responsible bodies to take control measures such as social distancing[1]. Due to its easy and rapid transmissibility, this disease called for the adaptation of technological advances and the reorganization of health services to maintain distancing, in which distance care measures were necessary and telemedicine actions authorized both within the scope of the Unified Health System (*Sistema Único de Saúde – SUS*) and the supplementary and private health sector[2,3].

Telerehabilitation uses information and communication technology to promote rehabilitation remotely, using strategies such as telemonitoring to help monitor these patients, either synchronously or asynchronously, with benefits similar to rehabilitation with face-to-face supervision. In addition, it minimizes barriers related to distance, time, costs and risks[4,5]. In Brazil, the Federal Council of Physical Therapy and Occupational Therapy, through resolution No. 516 of March 20, 2020[6], authorized telemedicine, teleconsulting and telemonitoring services that were already corroborated by the World Health Organization (WHO).

Access to rehabilitation programs in the most different areas has been compromised due to the COVID-19 pandemic. Since these programs mainly assisted risk groups, such as older adults and/or people with comorbidities, telerehabilitation and telemonitoring became interesting options to continue ensuring the provision of care to patients. This happened with Pulmonary Rehabilitation Programs (PRP) all over the world[7,8], which have proven to be effective in addressing functional exercise capacity, dyspnea, quality of life (QoL) and hospital admissions for chronic lung disease[9,10].

The evaluation of the effectiveness in the use of telehealth technologies is predominantly inclined towards the identification of positive impacts on and improvements in health-related quality of life. For some authors[6,11,12], however, achieving the same levels compared to traditional and outpatient follow-up models strengthens feasibility conditions for the adoption of such technological tools capable of overcoming eventual accessibility barriers while ensuring adequate conditions for patient follow-up.

Knowing the potential benefits of telemonitoring, it is of fundamental importance to present the experience of the protocol of a public institution in the Northeast region offered to the SUS community during the pandemic. It provided for continuity and follow-up of the treatment by a multidisciplinary PRP team in a moment of such serious public health

situation. This experience envisioned the coverage of a larger number of patients assisted by these programs, such as those who live in other municipalities and those who do not have the resources to travel as Chronic Respiratory Diseases (CRD) mainly affect populations with low income and education who are more exposed to risk factors and have less access to health services[10].

Thus, the present study aimed to assess the exercise capacity of chronic lung disease patients assisted by a Pulmonary Rehabilitation Program (PRP) in the COVID-19 pandemic after a strategy of telemonitoring physical exercises at home.

METHODOLOGY

A quantitative observational study was carried out from March to November 2020 at the Pulmonary Rehabilitation (PR) unit of the Dr. Carlos Alberto Studart Gomes Hospital in Messejana (HM), in Fortaleza, Ceará, Brazil, with a description of the strategy implemented in the service regardless of the research.

Convenience sampling was used to obtain a sample consisting of individuals with chronic lung diseases assisted by the Pulmonary Rehabilitation Program (PRP) of the HM. Patients aged 18 years or older, at any time of participation in the PRP, were included. Patients with cognitive limitations that could hinder performance of the proposed activities during the training delivered by the program team and those with cardiovascular alterations that contraindicated the performance of exercises without the supervision of a professional were excluded.

Telemonitoring was applied by three previously trained PRP professionals, two physiotherapists and one occupational therapist. An informative and educational guide for the service served as support to guide patients – the Home Pulmonary Rehabilitation Manual[13] – which was usually delivered at the time of discharge. Before starting telemonitoring, patients participated in an explanation and face-to-face training on the program protocol presented in the manual.

Telemonitoring was performed through telephone calls at times asynchronous to the exercise and in some specific circumstances. When there was a need for clarification about the performance of exercises or at the request of the patients, video calls were made and patients were asked about the time they performed the exercise, the number of repetitions, difficulties in performing the exercises, understanding of the guidelines, treatment progress, sensation of dyspnea using the Borg scale[14], clinical data such as oxygen saturation (SpO2), heart rate (HR), signs and symptoms and emotional state.

Only four patients had oximeters, but the Borg scale guided changes in strategies or interruption of exercises if Borg was above six[14]. This scale, even though it is very subjective and has little evidence, is widely used to identify exercise intensity in chronic lung disease patients as it manages to measure dyspnea at a given point in time and is easy to apply and has a low cost[15]. Patients were always motivated to follow the exercise manual by the professional during phone calls. The training was not done in real time together with the physiotherapist and the calls were normally made after the exercises.

In addition to phone calls, the PR team created chat groups in an application according to the group to which the patient belonged. Thus, during the face-to-face program and through this resource, video calls were made and content was sent (photos, videos, and informative and motivational texts). The application used was WhatsApp®, as it is the most popular instant messaging social media among Brazilians. In addition, all study participants had the application on their smartphones[16].

During telemonitoring, online medical care was provided and, when necessary, medical certificates were provided and patients were referred to Primary Health Care (PHC) centers, Urgent Care Centers (*Unidade de Pronto Atendimento – UPA*) or emergency rooms. There were also consultations with the social worker, occupational therapist, nutritionist and psychologist within the proposed support for social, emotional, functional and cognitive needs.

Patients were instructed to develop a specific routine for training at home, following guidelines such as: wearing appropriate and comfortable clothing and sneakers; oxygen dependents should use it during exercise; using a chair with support to rest between exercises; having music so that it could give rhythm to the movements; having a clock or stopwatch to keep track of time. In addition, some materials were used, such as: weights (dumbbells provided by the program, PET bottles with sand, non-perishable foods weighing 1 kg or up to 2 kg) and a stick.

The exercise should be performed in the best environment of the house and without interruption, always with the help and monitoring of someone in the family when possible. The exercises performed were based on the PRP protocol, using submaximal and safe loads determined during the face-to-face program.

The manual guided them to perform stretching of the most requested muscle groups, such as: triceps *surae*, quadriceps, hamstrings, pectorals, biceps, triceps and cervical muscles; interval warm-up exercises, such as static walking and shoulder and trunk rotations; conditioning of upper limbs (UL), through Kabat's diagonals, and LL, with seated knee extension and standing knee flexion; aerobic training, which consisted of walking and climbing stairs monitored by a stopwatch or by the wristwatch and Borg scale. The aim was to perform the exercises in two series of 10 to 12 repetitions each, walking for 30 to 45 minutes, corresponding to the same time achieved in the PRP on an ergometric treadmill, and 5 to 10 minutes on the step, accounting for a total time of exercises ranging from 60 to 90 minutes, at a frequency of 3 times a week.

After a drop in the number of cases during the pandemic in Ceará, patients returned to PRP, with the support of the HM Hospital Infection Control Commission (*Comissão de Controle de Infecção Hospitalar – CCIH/HM*), in September 2020 after six (6) months of telemonitoring. This procedure aimed to carry out the Six-Minute Walk Test (6MWT) and LL Incremental and Endurance Test in order to compare with the results prior to telemonitoring carried out by the same PR team under observation by the researchers.

The Six-Minute Walk Test (6MWT) followed the norms of the European Respiratory Society/American Thoracic Society[17] and was performed in a 30-meter long flat corridor in which the patients walked as far as possible for a period of six minutes, with incentives standardized every minute. HR, respiratory rate, SpO2, blood pressure, and the degree of dyspnea (the Borg scale) were measured at rest, at the end of six minutes and five minutes after the test. In the third minute, only HR, SpO2 and the Borg scale were measured.

The individualized prescription of the exercise tests was made by the LL Incremental and Endurance Tests. The first assessed, by means of load elevation and inclination, the maximum effort capacity following the Harbor protocol[18], which has an incremental character but with more gradual load increments, thus being more suitable for chronic lung diseases. This protocol consists of programming a comfortable speed for the patient, with a 1% increase in the incline of the treadmill every minute up to the limit referred by the patient as long as they manage to reach a time between 10 and 15 minutes, equivalent to an incline of 10% to 12%[19]. If they did not reach this time interval, the test was performed again on another day.

The second test followed a constant load, with 90% of the values found in the incremental test, observing the maximum time that the patient could keep exercising, being interrupted only at the patient's request or due to important changes in the clinical parameters. At the end of the test, all parameters were verified in the active recovery while walking two minutes at a minimum speed and without inclination and in the passive recovery after two minutes sitting. Additionally, the distance covered and the time reached were recorded[19,20].

The patients performed these tests on the Athletic Advanced 990T treadmill, being encouraged by the professionals who accompanied them to do the best possible according to their limitations. Thus, and subsequently to the tests, the patients reported the nature and intensity of the limiting symptom(s) according to the modified Borg scale[14].

The analysis of sociodemographic data and exercise, 6MWT, and lower limb incremental and endurance tests was performed using the Statistical Package for the Social Sciences – SPSS software (IBM SPSS Statistic for Windows, version 22.0, Armonk, NY, IBM Corp). Continuous data were presented as mean and standard deviations, while categorical data were presented as absolute and/or relative frequencies. The Shapiro-Wilk test evaluated the normality of data distribution and the independent Student's t test compared continuous data with normal distribution. The Wilcoxon test was used for data with non-normal distribution, adopting a significance level of less than 5% ($p<0.05$).

This study was approved by the Ethics Committee of the Dr Carlos Alberto Studart Gomes Hospital in Messejana under Approval No. 4.276.127 and is in accordance with the recommendations of Resolution No. 466/12 of the National Health Council[21].

RESULTS

General characteristics of the sample

Twenty-two individuals with chronic lung disease were included, 11 of whom completed the study. The sociodemographic characteristics of these individuals are described in Table I. The majority were female (73%), with a mean age of 55 ± 11 years, incomplete primary education (46%) and diagnosed with chronic obstructive pulmonary disease (COPD) (37%). More than half of the patients (55%) were in the range of 10 to 24 consultations in the PR when it was interrupted, that is, between one and two months of treatment, after which telemonitoring was started.

Table I - Sociodemographic characteristics of chronic lung disease patients in the study (n=11). Fortaleza, Brazil, 2021.

Characteristic	Valor
Sex F, n (%)	8 (73)
Age, years	55 ± 11
Weight, kg	72 ± 17
Height, m	1.58 ± 0.15
BMI, kg/m^{-2}	28.90 ± 3.93
PR time before telemonitoring	**n (%)**
3-9 consultations	2 (18)
10-24 consultations	6 (55)
25-36 consultations	1 (9)
37-144 consultations	2 (18)
Education	**n (%)**
Incomplete primary education	5 (46)
Complete primary education	2 (18)
Complete secondary education	2 (18)
Complete higher education	2 (18)
Main diagnosis	**n (%)**
COPD	4 (37)
Pulmonary fibrosis	3 (27)
Pulmonary arterial hypertension	1 (9)
Restrictive thoracic cage and lung disease	1 (9)
Restrictive lung disease to be clarified	1 (9)
Bronchiolitis	1 (9)

Data described as absolute and relative frequencies or mean ± standard deviations. F: Female; BMI: Body Mass Index; PR: Pulmonary Rehabilitation; COPD: Chronic Obstructive Pulmonary Disease

Impact on maximum exercise capacity

Figure 1 shows that in the LL Incremental Test, performed after telemonitoring (Post-Telem.), there was a decrease in time (707 ± 46 seconds) compared to that performed before PR (Pre-PR, 716 ± 60 seconds), but without statistical significance (p=0.50). Regarding the maximum speed achieved, there was a slight increase from 3.2 ± 1.0km/h in the Pre-RP to 3.3 ± 1.0km/h in the Post-Telem., also without statistical significance (p=0.70).

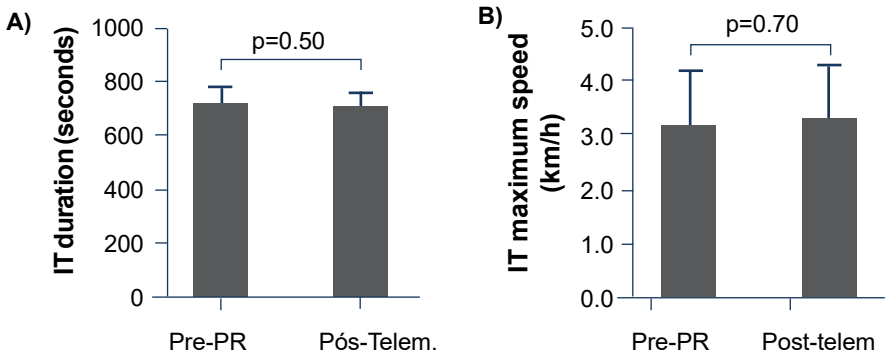

Figure 1. Comparison of duration (Figure A) and maximum speed achieved (Figure B) in the incremental test (IT) of the lower limbs between the pre-pulmonary rehabilitation (Pre-PR) and post-telemonitoring (Post-Telem.) moments.

Impact on submaximal exercise capacity

Figure 2 presents the results of the comparison between the endurance test and the six-minute walk test (6MWT) between the Pre-RP and Post-Telem moments. In the lower limb endurance test, there was a significant increase in duration, from 362 ± 209 seconds before PR to 1.142 ± 989 seconds after telemonitoring (p=0.003). With regard to the distance covered in the 6MWT, there was no significant result, with an average distance covered before the intervention of 426 ± 87 meters and 396 ± 97 meters after it (p=0.09).

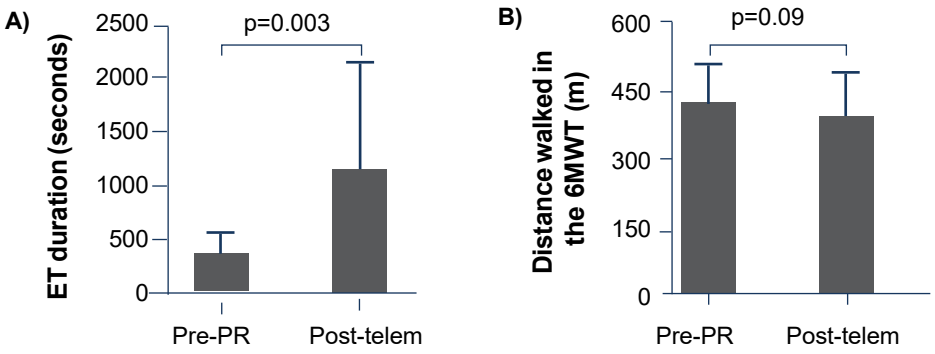

Figure 2. Comparison of the duration of the lower limb endurance test (ET) (Figure A) and the distance covered in the six-minute walk test (6MWT; Figure B) between the pre-pulmonary rehabilitation (Pre-PR) and post-telemonitoring (Post-Telem.) moments.

DISCUSSION

This study presented a detailed description of a pulmonary rehabilitation protocol for patients with chronic lung disease using telemonitoring, in which, in addition to virtual monitoring, participants received an informative manual for better support. As a result of the sociodemographic characteristics of the sample, the majority of the patients had a diagnosis of COPD, with a predominance of females and overweight. This profile is in line with the literature, differing only in terms of gender, as research shows that males are predominant in PRP as well as in telerehabilitation and telemonitoring[22,23].

Most individuals (46%) had not completed primary school, corroborating the literature that shows the predominance of chronic lung diseases in populations with low income and education, who are more exposed to risk factors and have less access to health services[11,24].

One of the first studies in patients with COPD examining the effects of home telerehabilitation with supervision in all exercise sessions was published in 2017[25] and used real-time videoconferencing. These patients were randomized into a supervised home telerehabilitation group (TG) that received physical training three times a week for eight weeks and a control group (CG) that received usual care without physical training. The results showed that after telerehabilitation there was a significant improvement in exercise capacity and self-efficacy and a tendency towards improvement in QoL when compared to usual medical care. Thus, as in the aforementioned study, it is possible to highlight, as test results, a significant improvement in submaximal exercise capacity, evidenced by the longer duration of the LL endurance test. Although the training was not able to promote significant improvement in functional capacity, the data remained acceptable as the clinical condition of the patients was not worsened.

The effectiveness of telerehabilitation has been proven not only in the respiratory area but also in the neurological, cardiological, orthopedic areas, along with other benefits of this modality that go beyond the physical effects, such as cost reduction and increased access to rehabilitation treatments for a greater number of people[11,26].

Research[27] suggests that pulmonary rehabilitation performed through telerehabilitation for people with chronic respiratory disease achieves results similar to those of pulmonary rehabilitation provided in traditional centers without safety problems. However, the certainty of the evidence provided by this review is limited by the small number of studies as well as varied models of telerehabilitation and few participants. These results corroborate the present study as it included a small sample and there was haste in choosing the protocol due to the “pandemic chaos” and lack of technological management skills by the team to be used in telemonitoring.

However, a systematic review dating from 2016[28] confirms the benefits of pulmonary rehabilitation programs with unsupervised home exercises for QoL and dyspnea in stable patients with moderate to severe COPD. In addition, it appears that this alternative form of physical training in the treatment of these patients is safe and feasible, but

further studies are needed to investigate the effects of self-monitored training on other outcomes. This indicates that although lacking much support and planning the current research managed to minimize and prevent problems that could be aggravated by the pandemic and lack of training, such as hospitalizations and contamination of these patients.

In addition to these limitations, an assessment of physical capacity was not carried out before starting telemonitoring so that a more accurate comparison of this period could be made since the participants had already started face-to-face treatment. Also, other equally important outcomes were not assessed, such as QoL and symptoms of anxiety and depression. Even though there were some questions related to the topics in the progression sheets, these were not measured.

CONCLUSION

The patients' exercise capacity improved after using telemonitoring as a strategy for continuing care for chronic lung disease, which makes it a feasible option to increase the accessibility of these patients to PRP as well as a more prolonged rehabilitation for those who need it, thus allowing patients to continue with their treatments at home safely and efficiently.

Despite the benefits, there is still a need for studies to determine the best therapy volume and the existence of a possible difference in relation to the synchronous or asynchronous form among these patients.

CONFLICTS OF INTEREST

The authors declare that there is no personal, commercial, academic, political or financial conflict of interest in this manuscript.

AUTHOR'S CONTRIBUTIONS

Luciana de Moraes Almeida Sousa, **Cyntia Maria Sampaio Viana**, **Débora Joyce Vasconcelos Gomes da Silva**, **Franciane Muniz Lucena Monteiro** and **Maria Tereza Aguiar Pessoa Morano** contributed to the study conception and design. **Rafael Mesquita** and **Gezabell Rodrigues** contributed to the acquisition, analysis and interpretation of data. **Alina Vasconcelos** contributed to the writing and revision of the manuscript. All authors approved the version of the manuscript to be published and are responsible for its content and integrity.

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