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ANALYTICAL ANALYSIS OF EXPERIMENTAL RESEARCH IN PUBLICATIONS REGARDING THE EFFECTIVENESS OF SPIROMETRY IN PATIENTS WITH COVID-19

BONDOC-IONESCU CRISTIAN¹, LUMINIȚA GEORGESCU¹

Abstract

The current study investigates recent experimental research published regarding to complications of respiratory conditions, especially in the context of the infection with the COVID-19 virus, an issue highlighted by the World Health Organization in 2020. These investigations provide recent and relevant evidence for the physiotherapy management of patients with COVID-19-related pneumonia and severe symptoms.

The research findings demonstrate that each experimental study, regardless of the demographic area, can contribute to establishing appropriate treatment for patient recovery, taking into account the functional status of the subjects based on age groups.

Keywords: Pneumonia COVID-19, physiotherapy, respiratory exercises, incentive spirometry.

Introduction

The COVID-19 pandemic has highlighted the need to improve respiratory function, by addressing adapted methods depending on the health state of those infected, by creating protection and sanitary hygiene guidelines in the viral disease transmission environment, via medical interventions, but also therapeutic publications of various geographical areas.

These publications have created a series of investigations with statistical results, from which specific guidelines applied on COVID-19 patients, in the practised of physiotherapy field have been raised.

The motivation

Due to my personal practical experience, I was motivated in approaching this topic by accessing a series of relevant publications in the field of physiotherapy, focusing on the respiratory system area of practice, encountering by reading numerous publications about various aspects of spirometry method, especially in similar interventions conducted in intensive care units, both internationally and in Romania, in the context of the pandemic caused by the SARS-CoV-2 virus.

Methods and materials

The research method involves an extensive analysis of numerous documentary materials related to the investigations results recently published in journals from several countries. These investigations focus on viral COVID-19 infection cases, in which spirometer testing, respiratory physiotherapy exercises and incentive spirometry have been applied.

The hypothesis of this of the observational research is based on the premise that, during the COVID-19 pandemic, the incentive spirometry exercises is an effective alternative therapy for optimizing lung function in patients diagnosed with COVID-19, both during hospitalization and in the post-hospitalization period.

Considerations regarding publications for the application of spirometry during and after COVID-19

The spirometric testing method in the context of the COVID-19 pandemic has been experimented within clinical, hospital, and community settings, as highlighted in the article "Considerations for Conducting Spirometry During and After COVID-19", published in the American Lung Association, through which certain considerations regarding spirometric testing have prompted recommendations according to a group from the European Respiratory Society, (McGowan et al., 2020, pp. 1-4), and the American Thoracic Society, which emphasizes the need for a careful evaluation of the risks and benefits of spirometry testing during this period.

An important aspect is the recommendation to restrict spirometric testing and only perform it in essential cases, according to Villalobos N. and Cirino E., who in February 2023, consider spirometric testing to be medically essential, being useful for the immediate diagnosis and treatment of pulmonary conditions, highlighting the importance of physiotherapists' knowledge in assessing the risks and benefits of spirometric testing, particularly in diagnosing dyspnea and monitoring pulmonary toxicity.

¹Scoala Doctorală Știința Sportului și Educației Fizice, UNSTP București – UPIT, Str. Târgul din Vale nr. 1, Pitești 110040; Corresponding author: cris.physio@yahoo.com, tel. +44 7481474704.

The significance of airborne and aerosol-generating procedures (AGPs) in the transmission of SARS-CoV-2 remains unclear, with uncertainties regarding the risks associated with these procedures in clinical and outpatient settings, and consequently, initially, the most common pulmonary treatments, such as spirometry and nebulization, were suspended.

A portion of the staff involved in the physiotherapy treatment and rehabilitation of COVID-19 patients have completely ceased these procedures, while others resumed them with restrictions and risk minimization strategies.

A report prepared and requested by the American Academy of Allergy, Asthma, and Immunology (AAAAI) provides suggestions for specialized staff performing pulmonary tests and treatments in the context of the COVID-19 pandemic, according to the guidelines provided by the group members. It offers recommendations for safely managing pulmonary procedures for an appropriate approach during and after the pandemic (Virant et al., 2022).

The spirometry method applied in the medical office is essential for diagnosing and monitoring patients with asthma. However, forced exhalation required for spirometry can generate aerosol particles, raising concerns about the spread of SARS-CoV-2, specifically forced vital capacity (FVC) maneuvers and maximal voluntary ventilation maneuvers, yet, there is a lack of consensus among medical organizations, such as CDC, OSHA, and ATS regarding the classification of spirometry as an aerosol-generating procedure (AGP). The American Lung Association does not classify testing as such but provides specific guidelines on conducting spirometry during COVID-19.

Studies show a temporary increase in aerosols during pulmonary function testing, but the actual impact on infection transmission remains unclear. Physical distancing and implementation of risk reduction measures are important during spirometry. These findings underline the need for a cautious approach and rigorous guidance to minimize risks associated with spirometry in the context of the COVID-19 pandemic. (Virant et al., 2022).

After each patient, the equipment should be cleaned with 70% isopropyl alcohol (or its equivalent) or the manufacturer's recommended disinfectant.

Another observational study conducted from May 2021 to June 2022, (Panthi, Kataria, Dhaliwal, Singh & Raghunathan, 2022) on a caseload of 199 subjects participating in the experiment. In this study, 142 patients underwent light breathing exercises, while 57 patients were involved in the assessment and use of incentive spirometry.

No major differences were observed compared between the mentioned groups, both in terms of demographic distribution and in terms of comorbidities, also oxygen requirement or HRCT score.

For the application of incentive spirometry, a spirometric ball mechanism was used. The main purpose of these exercises consisted to raise and maintain the balls at a pre-marked level for 3-5 seconds during inspiration, followed by a slow expiration for recovery. The exercises were repeated three times a day under the supervision and guidance of the physiotherapist. (Seyller, Gottlieb, & Colla, 2021).

We noticed that the result of the study highlighted that the group that performed light breathing exercises developed a higher tolerance to effort compared to the group that used incentive spirometry, therefore, a well-structured physiotherapy program with breathing exercises is better tolerated by COVID-19 pneumonia patients with mild or moderate symptoms, compared to performing incentive spirometry (Panthi N., Kataria, Dhaliwal, Singh & Raghunathan, 2022).

It has been determined that pulmonary physiotherapy is an essential component of the treatment protocol for patients with COVID-19 pneumonia following practical personal activity on various clinical stages.

When addressing therapies in subjects with COPD, a 2016 study, mentioned in the publication "Physiotherapy Intervention During Level I of Pulmonary Rehabilitation on Chronic Obstructive Pulmonary Disease: A Systematic Review," examined physiotherapy techniques used in hospitalized patients. This analysis included various symptom relief methods and techniques, such as high-frequency chest wall oscillation, active exercise relaxation massage, bronchial drainage technique, and incentive spirometry (Medeiros de Alvarenga et al, 2016).

In the context of COVID-19 pneumonia, specialized physiotherapists in pulmonary treatment have adapted the methods applied to COPD patients, highlighting similarities between the symptomatic manifestations of these patients and those with other respiratory pathologies. (Westerdahl, Osadnik & Emtner, 2019).

In various cases the COVID-19 pandemic has demonstrated that infected patients have presented with predominantly lung-related conditions, leading to interstitial pneumonia and subsequently severe hypoxemia and acute respiratory distress syndrome (ARDS). Thus, respiratory physiotherapy becomes an essential component in the multidisciplinary approach to caring for hospitalized patients (Navas-Blanco & Dudaryk, 2020).

In the following publication from 2023, as we found, a systematic review of statistical data was conducted to assess the prevalence of mortality cases due to of chronic pulmonary diseases among patients with COVID-19 from several countries, which highlighted the risk of progression to a more severe form of the disease in patients with bronchial asthma and COPD, who constituted the majority of subjects, as well as those diagnosed with lung cancer, but in a smaller number. (Zampogna, Zappa, Spanevello & Visca, 2020).

COPD patients have been informed about their predisposition to SARS-CoV-2 infection and the need for social isolation as a sanitary precaution (Awatade et al., 2023).

We note that the authors have identified a theoretical basis and clinical evidence suggesting that patients infected with COVID-19 and suffers from COPD have a limited prognosis compared to patients without COPD, where a study

conducted in the Republic of Korea, involving a caseload of 4610 patients infected with the SARS-CoV-2 virus, found that those with a medical history of COPD required admission to the intensive care unit and mechanical ventilation at a higher rate compared to patients without COPD. The resulting conclusion is that the presence of COPD was associated with a higher risk of mortality compared to other patients with other comorbidities (Awatade et al., 2023).

In some cases, patients with COPD have required mechanical ventilation support depending on the type of respiratory failure (i.e., hypoxemic or hypercapnic), as they may present with both hypoxemia and hypercapnia, benefiting from controlled oxygen therapy. COPD patients with severe COVID-19 should initially be maintained within a target range of 88–92% SpO₂, which may be adjusted to 94–98% following arterial blood gas (ABG) analysis confirming the absence of hypercapnia, and in the absence of an ABG tests, patients with COPD should be maintained within a target SpO₂ range of 88-92%. In severe COVID-19 patients, humidified oxygen and high-flow oxygen therapy have reduced the need for mechanical ventilation with conventional oxygen delivery (Awatade et al., 2023).

Studying and analyzing another publication from 2023, authored by Kusumawardani et al., we found that incentive spirometry was experimentally used with positive results in a caseload of twenty post-COVID-19 subjects who were randomly divided into two groups, one experimental group where incentive spirometry exercises were performed and a control group that underwent diaphragmatic breathing exercises (Kusumawardani et al., 2023).

The physiotherapy program was designed for performing exercises five times a day, applied over a period of four weeks, with ten sets each. The outcomes were recorded and measured via peak expiratory flow, both pre- and post-treatment.

The authors of this study found significant differences in lung function between the group that performed incentive spirometry exercises and the group that performed diaphragmatic breathing exercises, concluding that incentive spirometry could represent an effective alternative therapy for improving lung function in COVID-19 survivors.

Kusumawardani et al. mentioned that patients experiencing long-term persistent symptoms post-COVID-19 may also develop other conditions such as pulmonary fibrosis, which can affect lung function and lead to symptoms such as fatigue, dyspnea, cough, anxiety, and other cognitive and muscular problems (Kusumawardani et al., 2023).

Like these authors, we also have found through our personal experience that pulmonary rehabilitation is essential for such patients, aiming to reduce the impact of sequelae on pulmonary and vital functions, as well as to facilitate the return to activities of daily living (ADLs).

We continued the investigation by analyzing and reviewing pulse oximetry and spirometry data in a 2021 study that revealed the impact on forced vital capacity (FVC), forced expiratory volume in one second (FEV₁), and the FEV₁/FVC ratio. This experiment was conducted on 40 hospitalized patients diagnosed with COVID-19 pneumonia, aged between 28 to 78 years old. The assessment and enrolment in a monitoring pilot program was conducted under the guidance of a designated team prior discharge from the hospital, which consisted of providing each patient with an FDA-approved biophysical monitoring device for home use and training on its use. In the community, the provided device was capable of continuously monitoring vital parameters such as SpO₂, heart rate, respiratory rate, body temperature, and mobility data., by collecting intermittent data using an automatic blood pressure cuff and a portable spirometer. Out of the 40 patients, 27 completed both initial and final spirometry as well as pulse oximetry before discharge (Loudermilk et al., 2021).

The results of this evaluation revealed a significant increase in spirometric parameters between the initial and final testing. FVC showed an increase of 47.5%, FEV₁ showed an increase of 55%, and the FEV₁/FVC ratio increased by 4.1%. These changes were considered to be correlated with spirometry tests performed in the laboratory and represented a faithful reflection of the improvement in deficits identified during home testing.

These findings revealed the potential of such a study in terms of monitoring patients undergoing outpatient recovery, providing a new method for their assessment and management in their familiar environment.

We identified from the article titled "Practical considerations for spirometry during the COVID-19 outbreak: Literature review and insights" that specific clinical practice guidelines regarding the safe application of pulmonary function testing procedures were analyzed, with portable turbine spirometers being recommended. (Crimi, Impellizzeri, Campisi, Nolasco, Spanevello & Crimi N, 2020).

Discussions

This study is essentially a guidance document derived from the guidelines and recommendations applicable during the short period of the pandemic, which assisted healthcare staff and therapists in applying spirometry methods to patients with COVID-19 and those with post-COVID-19 symptoms, highlighting the differences between national healthcare systems worldwide, with limited resources during an epidemic period, thus not many research studies were found, even from various demographic and geographic areas. A need of increased number of physiotherapists with varied competencies in pulmonary recovery has been observed, especially in intensive care units, which led to the innovation and adaptation of short and well-tolerated respiratory exercise programs aimed at optimizing respiratory function in the recovery process of these patients, recommended via approved guidelines by UN (United Nations) and the World Physiotherapy Confederation (Thomas et. al., 2020).

The risks associated with spirometry usage handled by medical staff and applied to patients have been reduced by limiting testing to patients with clear diagnostic needs for asthma, while reconsidering the necessity of spirometry for patients with mild or stable conditions.

Conclusions

Following this observational and exploratory study on some problematic aspects and limitations of pulmonary technicians, which were commented on and experimentally argued, with restricted results regarding patients infected with SARS-CoV-2, as well as those presenting with different comorbidities, but especially those with COPD and other chronic lung diseases, in the context of the COVID-19 pandemic. We observed that the analysis and presentation of multiple studies have highlighted similarities regarding the necessity of conducting spirometry in a hygienic, controlled, and isolated environment, both for assessment and therapeutic purposes, under the guidance of a specialized respiratory physiotherapist or competent medical staff, both in clinical and community-based care settings.

We have attempted to highlight several subjective logistic causes of clinical and social restrictions, especially in cases where the continuation of treatment and monitoring at home could not be fully controlled, in terms of subjects' physical activity outside the exercise program, furthermore, the long-term effects of the physiotherapy program in these studies could not be measured.

However, we have identified opinions that highlight certain practical limitations on the effectiveness of therapeutic spirometry application, as well as recommendations from guidelines focused on managing COVID-19 patients, according to demographic and geographic distributions.

In light of the scientific and experimental limitations of these studies, we consider it necessary that further research is needed to be conducted to a more thoroughly research of the alternative therapy aiming to improve the pulmonary function.

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