EDITORIAL

PULMONARY REHABILITATION BETWEEN A PAST IN SHADOWS AND A BRIGHT FUTURE

BRIEF HISTORY OF PULMONARY REHABILITATION

During the last century numerous data and innovative ideas regarding pulmonary rehabilitation (PR) have accumulated worldwide, coupled with the development of an arsenal of new techniques for investigating and evaluating the respiratory function. It is an important advance in modern medicine and a concern for an expanding pathology. In parallel with humanity’s efforts to modernize, aiming for a high degree of civilization, the pathology is also growing. With the industrialization and urbanization of lifestyle, the human body, and especially the respiratory system, is subject to risk factors that are ever growing in harm.

The roots of the PR treatment have their origins in distant history. In the writings of the ancient peoples (Assyrians, Egyptians, Jews, Greeks and Romans) there is evidence of the use of natural physical agents for therapeutic purposes such as air, water, heat and light.

Laennec first described the concept of PR in 1821 and Charles L. Denison, a former patient with pulmonary tuberculosis, was one of the pioneers of respiratory physiotherapy. In 1880, Dr. Denison recommended breathing exercises for the rehabilitation of patients with tuberculosis in his work “Mountain Resorts with Therapeutic Effects” and in 1985 he also published an article titled “Exercises for the Lungs with Disabilities”.

In 1942, the National Rehabilitation Association (NRA), the oldest professional member organization in the United States, defined rehabilitation as a restoration of the individual in terms of the medical, mental, emotional, social, and vocational potential of which the patient is capable of. PR is extremely effective for lung diseases and the basic prototype it was founded upon was the patient with chronic obstructive pulmonary disease (COPD).

In 1981, the American Thoracic Society officially supported the PR of COPD patients. In 1984, after extensive study, Dr. John Hodgkin published the paper “Pulmonary Rehabilitation - Guidelines for Success” which included the official definition of PR and the structure of practical PR programs. With the publication of these papers, the interest and involvement of physicians and medical associations has grown, and their contribution has been observed to this day: “American Association for Respiratory Care”, “American Association for Pulmonary and Cardiovascular Rehabilitation”, “American Thoracic Society (ATS)”, “European Respiratory Society (ERS)”.

The concept of rehabilitation also entered Romania in 1969, when the statistics of the Ministry of Health estimated that 3% of the active workforce had lost their work capacity and recovery and thus reintegration measures were required. In the 1970s, the managements of the County Sanitary Directorates from Iasi and Cluj offered to
the Ministry of Health a solution to the problem by setting up rehabilitation hospitals in these two university centers that would fully meet the health requirements of modern medicine. By Decree 296 of 1973, the Ministry of Health approved the construction of rehabilitation hospitals in the municipalities of Iasi and Cluj.

In 1974, at the fifth session of the Romanian Academy of Medical Sciences, the first guidelines for PR were drawn, and in recent years we are witnessing an explosion of PR services and various techniques and devices used in the rehabilitation of lung patients. These respiratory therapies complement the pharmacological treatment and represent the cornerstone of the management of these patients.

The year 2006 was a significant year in the history of pulmonary rehabilitation due to internationally publishing the Joint Declaration on PR by ATS / ERS while in Romania the Working Group on Respiratory Rehabilitation of the Romanian Pneumology Society was created at the proposal of the undersigned, and with the support of the Romanian Pneumology Society Board, as a representative of the Rehabilitation Clinical Hospital and the “Grigore T. Popa” University of Medicine and Pharmacy from Iasi. Research in this field is in full swing worldwide and in our country (1).

PULMONARY REHABILITATION-OBJECTIVES, EVALUATION

PR treatment occupies a central place in patients with chronic lung disease, being recognized by all specialists in the field. The current definition of PR, according to the Official Report of the American Thoracic Society Workshop published in May 2021, is based on definitions previously developed, on scientific evidence, by PR specialists, which were published in 1974 and updated in 2006, 2007, 2013 and 2015, respectively. According to this report, “pulmonary rehabilitation is a comprehensive intervention based on an announced patient assessment, followed by patient-friendly therapies, which includes, but is not limited to, training, medical education and behavior change designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health-enhancing behaviors” (2).

Pulmonary rehabilitation is an extremely effective treatment for people with chronic lung disease, including post-COVID-19 respiratory sequelae, which is still underused worldwide. The conditions that can benefit from pulmonary rehabilitation are:

a) lung diseases with obstructive ventilatory dysfunction: COPD, asthma, bronchiectasis, cystic fibrosis, bronchiolitis obliterans;

b) lung diseases with restrictive ventilatory dysfunction: interstitial lung diseases (pulmonary fibrosis, occupational or environmental lung diseases, sarcoidosis, scleroderma, lymphangiomytomatosis, post-COVID-19), thoracic wall deformities (kyphoscoliosis, spondylitis ankylosis) restrictive ventilatory dysfunction;

c) other pathological conditions: lung cancer, pre / post lung transplant conditions, pre / post thoracic and abdominal surgical conditions with ventilatory dysfunction, pre / post LVRS (Lung Volume Reduction Surgery) conditions, ventilator dependence, pediatric patients with respiratory diseases, respiratory diseases related to obesity, autoimmune diseases with pulmonary involvement, pulmonary hypertension (3, 4, 5).
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Initial assessment of patients for inclusion in the PR program involves: detailed history and a correct clinical examination, assessment of contraindications for the rehabilitation program, assessment of smoking status, assessment of nutritional status, measurement of peripheral muscle strength, assessment of dyspnea and fatigue, performance evaluation of daily activities, quality of life assessment, medical education assessment, respiratory function assessment, exercise capacity assessment, electrocardiogram, echocardiogram, chest imaging assessment, additional needs assessment ± other investigations depending on the patient’s comorbidities.

Comprehensive and thorough patient assessment is essential for personalizing the PR program and for effectively addressing the objectives of individual PR programs tailored to the patient’s needs. In recent years, new models of PR programs have emerged, which aim to improve patient access, tailored to their needs, including telerehabilitation and low-cost models useful for PR at home. Quality assurance processes for PR programs are important to ensure that any PR service delivers optimal outcomes for patients and health services. The success of these PR models is assessed by the achievement of the essential components of the PR programs and the expected results of the patient, including improved exercise capacity, reduced symptoms, especially dyspnea, fatigue, cough, sputum, chest pain, anxiety and depression, reduced hospital admissions and improved health-related quality of life (6, 7, 8).

PULMONARY REHABILITATION AND LONG-COVID SYNDROME

The onset of SARS-CoV-2 coronavirus in December 2019 in Wuhan, China, and its rapid spread to over 216 countries has had a profound impact on humanity, leading to an unprecedented global crisis, both economically, socially and medically while also representing the biggest challenge we faced after the Second World War.

Experience, as well as studies conducted during this pandemic, have shown us that although COVID-19 is primarily a respiratory disease, the virus can affect other organs and systems of the body, which are manifested by characteristic symptoms. This is mainly due to the ubiquitous distribution of the SARS-CoV-2 virus receptor, a virus that causes systemic disease, with possible involvement of the heart, liver, pancreas and kidneys, causing changes in circulating lymphocytes and the immune system.

The impact of the severity of acute respiratory syndrome-coronavirus-2 may persist in some cases months after the initial illness, requiring individualized assessment and long-term follow-up for early detection of lung sequelae and correction of imbalances.

Long-COVID syndrome is defined as the syndrome that marks what is known so far: the persistence of COVID-19 disease symptoms 6 to 12 months after the acute phase, which are not explained by any other alternative diagnosis. It is characterized by the existence of a symptomatic corollary such as: fatigue, dyspnea, chest pain, cough, anosmia, dysgeusia, migraines, joint and muscle pain, cognitive dysfunction, etc., which proves that there are multiple organs involved (lung, cardiovascular, skin, neuropsychic, etc.), of which the lung suffers in two important areas, pulmonary fibrosis with or without traction bronchiectasis, pulmonary nodules and pleurisy, being the head of the poster,
followed in the second time by lung infections.

There are frequent cases that pass the acute period and are transferred from COVID-19 to non-COVID-19 services, due to the persistence of these accusations or their aggravation, the dyspnea being severe, with immobilization in bed and oxygen requirement between 10-15 L/min or non-invasive ventilation. It is true that in terms of symptoms, after post-COVID-19 recovery, 87.4% of patients have at least one persistent symptom, only 12% are asymptomatic after 2 months and in 51% of patients the quality of life is affected. These expressions are only the tip of an iceberg that can take a turn of gravity at any time (9).

In a clinical approach to post-COVID-19 status, a key concept is highlighted, namely the universal issue of rehabilitating post-SARS-CoV-2 sequelae, which is a complex concept that is not limited to the Real Time Test-The Polymerase Chain Reaction (RT-PCR) negative or the presence of anti-SARS-CoV-2 antibodies. The same approach points out that there are still many unknowns related to COVID-19 disease, especially in the post-acute phase, in terms of the persistence of symptoms and the severity of long-term respiratory sequelae, as well as other complications (neurocognitive, cardiac, renal, etc.) (10).

To develop a rehabilitation program for post-COVID-19 patients, the PR team has a well-recognized and widely accepted option: reproducing the PR algorithm for patients with chronic pulmonary disease (COPD). However, these patients need precise triage and a set of basic fundamental assessments to provide special rehabilitation programs (in-hospital, outpatient, tele-coaching, telerehabilitation, home rehabilitation), because the trajectories of phenotypes are very different and are not always related to hospitalization in the intensive care unit.

The benefits of PR programs for various chronic lung diseases have been demonstrated in numerous studies over time, and increased findings are currently being made on the favorable short- and long-term effects of including post-COVID-19 patients in these programs, highlighting the crucial role of rehabilitation specialists (11).

Long-term follow-up is a new challenge and is strongly recommended in these patients to detect time-consuming lung sequelae and appropriate management for their dysfunction. Monitoring of post-COVID-19 patients in specialist outpatient clinics and/or hospitals allows early assessment of symptoms (fatigue, dyspnea, cough, chest pain, depression and anxiety, etc.), of physical performance and lung function, which allows the application of the PR program, as well as the organization and tracking of this complex treatment. Early complex and comprehensive PR intervention in these patients certainly demonstrated a significant reduction in symptoms at 1, 3, 6 and 12 months, respectively, after the acute episode and an increase in physical and cognitive performance, and overall quality of life (12, 13).

**PULMONARY TELEREHABILITATION**

The last two years have presented us with a brand-new challenge: telemedicine, which is defined by the World Health Organization as “the provision of healthcare services, where distance is a critical factor, by all healthcare professionals, through the use of information technologies and communication, for the exchange of valid in-
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formation for the diagnosis, treatment and prevention of diseases and injuries” in which pulmonary telerehabilitation (tab. I) occupies an important place (14).

**TABLE I.**

Pulmonary telerehabilitation: advantages and disadvantages (15, 16)

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
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<tbody>
<tr>
<td>• The patient is in a family environment;</td>
<td>• Patients need to know technology;</td>
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<tr>
<td>• Allows the patient to be autonomous, confident;</td>
<td>• Requires internet connection;</td>
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<td>• The rehabilitation process is facilitated, and a</td>
<td>• Inability to perform the PR program without the presence of a qualified</td>
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<td>real acceleration can be observed;</td>
<td>and trained medical staff for what it means to assist in pulmonary</td>
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<tr>
<td>• Telemedicine / telerehabilitation removes</td>
<td>rehabilitation;</td>
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<tr>
<td>geographical and distance barriers;</td>
<td>• There is currently no legal framework in Romania to regulate the activity</td>
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<tr>
<td>• Everything can take place on secure medical</td>
<td>of telemedicine;</td>
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<tr>
<td>communication platforms, where data confidentiality</td>
<td>• Lack of transparency regarding data security;</td>
</tr>
<tr>
<td>is strictly maintained;</td>
<td>• Lack of information and trust regarding specific eHealth solutions</td>
</tr>
<tr>
<td>• Reduce healthcare costs;</td>
<td>among patients, citizens and healthcare professionals.</td>
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| • Saving the time needed to travel home;             | **Telerehabilitation at home is a useful option for patients who are in the period after an acute illness and cannot be taken over by the rehabilitation centers but need to start the rehabilitation program as soon as possible.** Although pulmonary rehabilitation is a well-established therapeutic method, with proven benefits, 8-40% of patients referred for hospital PR programs do not adhere to them, while 10-30% of those who start the program do not complete it.

Telerehabilitation is a therapeutic tool that can be used successfully in patients with chronic respiratory diseases. Studies comparing telerehabilitation with standard rehabilitation have shown favorable results in increasing exercise capacity and reducing symptoms, as well as improving the quality of life of patients with chronic lung disease (17).

Telemedicine has proved its worth in the midst of the pandemic, when health and distance rules made it inaccessible for patients to participate in rehabilitation programs, including patients with SARS-CoV-2 infection, both in the acute phase and the post-COVID-19 state, manifested predominantly by respiratory symptoms during rest and exertion, for which PR is required. In this context, telerehabilitation has been an extremely important aid. It has been used successfully in Wuhan hospitals, where patients with COVID-19, isolated in wards, have been given, through a telephone application, models of aerobic exercise, resistance training with elastic bands, and exercises for training the respiratory muscles, in the form of videos or written recommendations. The exercises were also recorded, the application having a symptom monitoring system, which was transmitted from patients to doctors.

In a multicenter study conducted in Australia, which assessed the access of patients with chronic respiratory diseases to technology, out of 254 participants, 92% had access to at least one electronic device,
is interesting. What appeared to be a field or an uncertainty with obscure benefits, it is now supported by evidence classified by experts to be of the highest standard. There is also hoped that the upcoming years will provide even newer and more exciting ways for a wider and more important role of PR in a futuristic version of the field.

Specific assessment of each patient to achieve adequate results, long-term effects and maintaining the benefits of PR in the individual patient, the most appropriate access of PR to the early onset of disability, overcoming potential barriers, raising awareness of this science to people/patients and to professionals, the incorporation of new technologies and the principles of e-health are all real frontiers to be explored in order to improve PR.

This is an interesting and opportune time for pulmonary rehabilitation, which can bring new opportunities and allow the exploration of new areas in search of improvement. Overall, the future of pulmonary rehabilitation will include more patient options and greater program customization, while comprehensive patient assessment should continue to be a benchmark for all programs and models.

CONCLUSIONS
The history of pulmonary rehabilitation

REFERENCES
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