

HYPERBARIC THERAPY IN COVID-19 AND LONGCOVID SYNDROME – A REVIEW OF JOURNAL DATABASES

Ewa Zieliński¹⁾, Piotr Dzięgielewski²⁾, Marek Kowalczyk³⁾, Gabriela Henrykowska⁴⁾, Piotr Siermontowski⁵⁾

¹⁾ Department of Emergency Medical Services, Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Poland

²⁾ Inspectorate of the Military Health Service in Warsaw, Poland, Poland

³⁾ Department of General, Minimally Invasive and Elderly Surgery of the UWM in Olsztyn, Poland

⁴⁾ Department of Epidemiology and Public Health Medical University of Lodz, Poland

⁵⁾ Department of Underwater Works Technology, Naval Academy, Gdynia, Poland

ABSTRACT

This article presents a review of available research on the use of hyperbaric oxygen therapy (HBOT) in the treatment of acute COVID-19 and long COVID syndrome. The analysis included papers published in peer-reviewed scientific databases and clinical projects registered in international registries. In most clinical reports, including small groups of patients from China, the USA, Israel, and Europe, HBOT was associated with improved oxygenation parameters, reduced need for mechanical ventilation, reduced mortality, and a beneficial effect on neurocognitive functions and symptoms of post-COVID syndrome. The results also indicate the potential of HBOT in mitigating inflammatory processes and improving patients' quality of life. At the same time, all studies emphasize the limited sample size, lack of standardized protocols, and the need for further randomized controlled trials. The authors highlight the threat posed by the unauthorized use of so-called "soft chambers" for commercial purposes, which do not meet medical standards and may pose a serious risk to patients. The conclusion is that HBOT is a potentially promising therapy, but should currently only be used in controlled clinical trials or in exceptional situations after careful consideration of the benefit-risk ratio.

Keywords: hyperbaric medicine, SARS-CoV-2, longCOVID, scientific databases, hyperbaric chambers.

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INTRODUCTION

In accordance with the recommendations of the European Commitment for Hyperbaric Medicine (ECHM) and European Underwater and Baromedical Society (EBUS), the beneficial effect of hyperbaric therapy on the treatment of some patients with COVID-19 cannot be excluded, but this requires further research and expanding knowledge within planned and ethically approved randomized scientific trials. Research on the use of hyperbaric oxygen therapy (HBOT) in patients with COVID-19 began in 2020. Considering the risk, availability of scientific and therapeutic base and experience, only a few clinical centers, e.g. from China, France and the United States, could undertake such studies. Scientific reports from these research centers are promising since they show prevention of further deterioration of the patient's condition and no need for intensive care. Unfortunately, some studies were not completed or were interrupted.

EPIDEMIOLOGY OF COVID-19 AND THE APPLICATION OF HYPERBAROTHERAPY IN COVID-19 AND LONGCOVID.

Covid problem, which appeared after the spread of the SARS Cov2 virus from Wuhan in 2019, aroused fear and panic around the world. The essence of the disease was and is the destruction of lung tissue, causing in severe cases acute atypical pneumonia and acute respiratory distress syndrome. The desperate situation in the developing pandemic and the invasiveness of the virus led to many works on finding effective treatment, which in many cases (as we know today) ended in failure. The invention of vaccines also had to take time. The serious conditions of patients, shortages of both staff and equipment, but above all the development of the pandemic became a challenge.

Hyperbaric therapy has been used in medicine for years. During a session in a hyperbaric chamber, the patient breathes 100% oxygen in an atmosphere of increased pressure (>1 ATA). To maintain proper cellular metabolism, tissues at rest need about 60 ml of oxygen per liter of blood. When a patient breathes 100% oxygen at a pressure of 3 atmospheres, the amount of oxygen dissolved in the plasma increases almost 20 times and is about 60 ml per liter of blood. In addition, the effect of hyperbaria on the inflammatory process and reports of the neuroprotective role of HBOT probably caused researchers from around the world to become interested in this method. They recognized that the therapy would most likely have a positive effect and would support the fight against Covid-19. The interest in the use of hyperbaric oxygen therapy became a natural consequence of the association of the main symptoms of Covid-19. Respiratory failure resulting from fibrosis of the lung tissue, and thus the lack of oxygen in the body, required long-term and highly effective normobaric oxygen therapy, often with the need for intubation and intensive treatment in Intensive Care Units (ICU).

As is commonly known, the bodies that make decisions on recommending a specific method of treatment are Medical Societies. We are already accustomed to the UCHM and EBUS recommendations from 2004, on which the treatment of acute and

frightening diseases using hyperbaric oxygen is currently based. This is also a recommendation in Poland for the National Health Fund (NFZ) to reimburse HBOT therapy. Medical Societies, when issuing recommendations for HBOT in multi-place chambers, indicated at the same time the need to abandon or postpone therapy in some patients with suspected or confirmed diagnosis of COVID-19. Patients at risk of losing a limb, sudden idiopathic deafness or central retinal artery embolism were positively qualified for therapy.

Being aware that during the pandemic at least several clinical trial projects were being conducted around the world using HBOT as an adjunctive therapy in COVID-19, EUBS and ECHM indicated that the use of this therapy is experimental and should be carried out as part of planned and ethically approved randomized scientific studies.

SCIENTIFIC REPORTS ON THE USE OF OXYBAROTHERAPY IN PATIENTS WITH COVID-19 – SELECTED ISSUES

The report will only present clinical studies that have been officially reported, registered in scientific databases and have specific therapeutic protocols prepared in accordance with scientific research standards.

China was the first country to report the use of HBOT therapy in people with Covid-19. This should not surprise us, because it was the original center of the pandemic. In addition, there are about 5,000 hyperbaric chambers in China. Several authors have proposed randomized studies and studies with control groups based on reports from Chinese papers.

Table 1 below presents the efficacy and safety of hyperbaric oxygen treatment in SARS-COV-2 pneumonia (COVID-19) [1].

Tab. 1

Efficacy and safety of hyperbaric oxygen therapy in SARS-CoV-2 pneumonia (COVID-19).						
lp	Author/ /country	Study design - number of subjects examined "n"	Criteria	Exclusion	Chamber type, HBOT - conditions	
1	Chen [2]/China	Cases n=5	Progressive hypoxemia, moderate to severe ARDS, laboratory confirmed	lack	Multiplace, 203 kPa for one patient, 162kPa for four patients, 60-90 min. Five HBOT sessions on average	
2	Gorenstein [3]/USA	Cohort study with a control group selected from patients treated in the same hospital and during the same period n=80 (20 interventions, 60 controls)	Age ≥ 18 years, laboratory confirmed COVID-19, SaO ₂ <93%	Severe pneumothorax, positive troponins	Monoplace, 203 kPa, 90 min once a day for five days	
3	Guo [4]/China	Cases n=2	Confirmed COVID-19 and one of the following: dyspnea; respiratory rate ≥ 30/min; SpO ₂ ≤ 93% at rest; P/F ratio ≤ 300mmHg	Pneumothorax (pulmonary bullae)	Monoplace, 152 kPa, 60 min once a day for seven days	
4	Qian [5]/China	Cases prospectively, n=4	Progressive dyspnea, area of changes in lung CT > 30%, SpO ₂ < 90% in air	Pneumothorax (pulmonary bullae)	Portable single-place chamber; 152kPa, 90 min, once a day for seven days	
5	Thibodeaux [6]/USA	Retrospective cases, n=5	Life-threatening respiratory failure, risk of intubation	lack	Chamber type not specified, 203 kPa , 90 min. Average of five HBOT sessions (range 1- 6)	
6	Zhong [7]/China	Case, n=1	Seriously ill with pneumonia and tracheal intubation, confirmed COVID-19 by tracheal aspiration	lack	Multiplace, 162-182 kPa, 90 min. Four HBOT sessions	

This is the first group of works, 4 of which come from China and 2 from the USA.

The only one out of these studies (USA) concerned a cohort study involving 80 subjects (including 20 infected individuals and 60 control subjects). The therapeutic pressure described in the study protocols did not exceed 2 ATA, which is consistent with the recommendations of the ECHM and EBUS guidelines already cited. In addition, most studies were performed in single-place chambers, and even in one study a "multiplace" chamber was used to perform compression on only one patient (China, Zhong). This was dictated by the availability of equipment, the risk of staff infection, difficulty in disinfection and the size of the study groups (they did not exceed 5 people). Most studies specified the rules for excluding patients from the study. All studies indicated a small study group and the need to conduct further randomized studies on a larger population. Gorenstein SA study deserves special attention [3].

This work has been reviewed in both the PubMed database and the journal Undesea and Hiperbaric Medicine , as well as in the knowledge base collected by the World Health Organization (WHO). The source is open - anyone interested has full free access to the results of this work. The aim of the study conducted in the USA at the Winthrop New York Hospital was to check the safety and effectiveness of oxybarotherapy in patients with COVID-19 with respiratory disorders.

It was a single-center clinical trial of patients with COVID-19, conducted from March 31 to April 28, 2020. Patients participating in this study were treated with hyperbaric pressure of 2.0 atmospheres in single-place hyperbaric chambers for 90 minutes, once a day, for a maximum of five full treatments. The therapy was performed on 20 patients with COVID-19 aged 30 to 79. The oxygen flow per minute ranged from 2 to 15 liters. The entire treatment lasted up to 14 days and took place in the hospital. The results of the studies show that oxybarotherapy is an effective method used in patients with COVID-19. It turned out that with the use of HBOT, a smaller group of patients required intubation. In addition, a lower mortality was shown in the group of patients given hyperbaric therapy and none of the people treated in this way required a longer hospitalization. Table 2 below presents cohort studies with a control group selected from patients treated in the same hospital and during the same period, published by Gorenstein SA.

Tab. 2

Studies with a control group selected from patients treated in the same hospital and during the same period.		
	From HBOT	CONTROL GROUP
NUMBER OF PATIENTS IN THE GROUP	20	60
INTUBATED PATIENTS	2 (10%)	18 (30%)
PATIENTS DEAD	2 (10%)	13 (22%)
FURTHER HOSPITAL TREATMENT REMAINED	0	3 (5%)

Source [3].

Below is a brief summary of the first papers published in the journal Diving Hyperb Medicine [8].

Five studies were found: three from China and two from the USA. A total of 97 patients were included in these studies, including 37 patients who received HBOT and 60 controls (only one study had a control group). Improvements in clinical (e.g. survival), biological (e.g. lymphocyte count, renal function) and imaging (e.g. chest CT) outcomes were observed in most of the 37 patients with COVID-19 hypoxemia across all studies. However, improvement of oxygen saturation occurred in 17 patients (five studies). Early data show that HBOT may be a useful therapy in preventing deterioration requiring intubation and mechanical ventilation in patients with COVID-19. Unfortunately, all studies were of low reliability and the certainty of evidence was also low or very low, except for one comparative study from the USA, which conducted a cohort study with a control group selected from patients treated in the same hospital and

during the same period, n = 80 (20 interventions; 60 controls). All studies concluded that the use of HBOT in the treatment of patients with COVID-19 may be promising but urgently requires randomized controlled trials [8].

By analysing the medical databases in which clinical trials are registered, i.e. the databases of the US National Library of Medicine, www.clinicaltrials.gov and the database of the European Medicines Agency (EMA) www.clinicaltrialsregister.eu, 14 research projects were found, of which: 6 came from the USA, 2 from Israel, 1 from Argentina, 1 from Canada, 1 from Germany in cooperation with Sweden, 2 from Sweden and 1 from France.

Table 3 below presents the works registered in the above databases: US National Library of Medicine and EMA.

Tab. 3

Research papers registered in the US National Library of Medicine and EMA databases.								
lp	Title of work/research	Country	Research center	Study start date	Study Date	End	Number of people tested	Summary of the assumptions of the registered study
1	Hyperbaric oxygen for COVID-19 patients with moderate to severe hypoxemia	USA	NYU Wirthrop Hospital Minecia, New York	15.12.2022	06/15/2023		360	Among many therapies proposed for COVID-19, few directly address severe hypoxia in patients with COVID-19. Preliminary results suggest that hyperbaric oxygen therapy may reduce hospital mortality or the need for mechanical ventilation among patients with COVID-19.
2	Hyperbaric versus normobaric oxygen therapy in COVID-19 patients	Canada	Hyperbaric Medical Center Scarborough, Ontario Canada	15.04.2021	08.2022		234	Researchers propose testing the effectiveness of HBOT in COVID-19 patients who are admitted to hospital to receive supplemental oxygen. Using the most rigorous and innovative research methods, this international Canadian-led study will be conducted in 5 centers in 3 countries: Canada: Ottawa and Toronto, Edmonton; Switzerland: Geneva; and the United Kingdom: Rugby/London.
3	Safety and Efficacy of	Germany/Sweden	Krankenhaus St. Joesf, Regensburg	03.06.2020	31.12.2022		200	The general hypothesis of the researchers was that

	Hyperbaric Oxygen for ARDS in COVID-19 Patients		Germany; Bielongesjukhuset Kariskrona Bielonge Sweden Sahigrenska University hospital, Ostra sjukhuset Gothenburg , Karolnska University Hospital Stockholm				HBOT reduces mortality, increases tolerance to hypoxia, and prevents organ failure in patients with COVID-19 pneumonia by attenuating the inflammatory response and consequently may prevent ICU admission and reduce mortality.
4	Use of hyperbaric oxygen therapy by "Compassionate use "	USA	White River Wound Healing Center Babesville. Arkansas, United States Community Hospital Monterey, California, United States Innovate Healing Systems Tampa, Florida, United States	15/04/2020	11.05.2022 (assumed 2-year retrospective analysis)	The number of people examined was not given	"Compassionate" use" - compassionate use of medicines programs. Retrospective analysis will focus on reducing the need for mechanical ventilation in patients with COVID-19. Information will be collected prospectively. Data will be collected from patient medical records, including medical notes and data recorded in the study database.
5	Hyperbaric oxygen as adjunctive therapy in patients with severe hypoxemia COVID-19, study stopped (marked as completed)	Argentina	Hospital Central de San Isidro Dr. Angel Melhor Posse San Isidro, Buenos Aires Hospital de Infecciosas FJ Muniz Ciudad Autonoma de Buenos Aires, Caba, Hospital General of Agudas De.F. Santojanni, Ciudad Autonoma de Buenos Aires, Caba	06.07.2020	30.12.2020	80	Following the reports of Chinese researchers, the authors of this study propose to evaluate whether HBO T treatment can improve the evolution of patients with severe hypoxemia of COVID-19. Conclusions: HBO T in the treatment of COVID-19 and severe hypoxemia is safe and effective [9].
6	Use of hyperbaric oxygen therapy in the treatment of COVID-19 patients with respiratory disorders	USA	Morton Hospital Taunton Massachusetts	15/02/2021	December 2021	10	The researchers aimed to collect data to determine whether HBOT would provide any benefit to a COVID-19 positive patient with mild to moderate respiratory distress. They compared a group of patients who had previously been treated for COVID-19 and received HBOT with those who had not been treated in a hyperbaric chamber.
7	Hyperbaric Oxygen Therapy (HBOT) as a treatment for COVID-19 infection.	USA	Ochsner Medical Center New Orleans, Louisiana	April 2020	June 2020	48	Patients who meet the inclusion criteria will be randomly assigned to a treatment or control group. The treatment groups will receive hyperbaric oxygen therapy (HBOT) and be compared to the control group.
8	Hyperbaric oxygen in people with long COVID having pulmonary complications	USA	University of California San Diego La Jolla, California	06.11.2021	31.12.20203	24	The impact of HBOT treatment in chronic COVID-19 patients with persistent pulmonary symptoms following SARC CO-2 infection

	following COVID-19.							
9	Hyperbaric oxygen therapy in post COVID-19 syndrome	Israel	Assaf – Harofeh Medical Center Zerifin	14.12.2020	10.01.2022	91	The purpose of this study is to compare the effects of HBOT on post-COVID-19 syndrome. The treatment group will be exposed to 100% oxygen via mask at 2ATA for 90 minutes with five minutes of air breathing breaks every 20 minutes. The control group will be exposed to 21% oxygen for 90 minutes at 1.2 ATA for the first five minutes of the session, then slowly decreased over the next 5 minutes to 1.03 ATA.	
10	The effect of hyperbaric therapy in the COVID-19 study	Israel	Assaf – Harofeh Medical Center Zerifin	30.04.2020	01.11.2020	31	The aim of the study is to assess the effectiveness of HBOT in patients with moderate COVID-19 in a randomized trial.	
11	Hyperbaric oxygen for COVID-19 patients.	USA	NYU Winthrop Hospital Mineola, New York	06.04.2020	22.06.2021	80	This is a single-center, prospective, pilot cohort study evaluating the safety and efficacy of hyperbaric therapy as an experimental rescue treatment for patients with COVID-19. Patients meeting the inclusion criteria will receive consent from a hyperbaric physician [3].	
12	Application of hyperbaric oxygen therapy in patients with hypoxic pneumonia from SARS-CO2 (COVID-19)	France	Hospital d'Instruction of the Armies Laveran Marseille, Center Hospitaller Intercommunal de Toulon – Laseyne - sur-Mer Toulon, France. Hopital d'Instruction des Armees Saint-Anne Toulon France	14.04.2020	April 2022	100	The primary objective is to assess the efficacy of HBOT as an adjunct to normal management during the period of normalization of oxygen demand in patients with SAR-CO2 pneumonia not requiring invasive or non-invasive ventilation. In both groups, standard continuous treatment with normobaric oxygen will be maintained.	
13	Hyperbaric oxygen therapy in non-ventilated patients with COVID-19.	USA	Malmonides Medical Center Brooklyn, New York	01.06.2020	31.01.2021	30	The study is a prospective, randomized, controlled, double-blind clinical trial conducted in laboratory-confirmed COVID-19 infected patients admitted to Shamir Medical Center. The study includes patients who will undergo hyperbaric oxygen therapy HBOT or normobaric oxygen therapy NBOT.	
14	Safety and effectiveness of hyperbaric oxygen therapy in Long COVID syndrome.	Sweden	Karolinska University Hospital Stockholm	09/15/2021	31.12.2023	80	A randomized, placebo-controlled clinical trial of hyperbaric oxygen as a potential treatment for patients with long-term Covid. The general hypothesis to be evaluated is that hyperbaric oxygen	

alleviates associated Covid.	symptoms with Long Covid.
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Source: Own study based on the journal databases of the US National Library of Medicine and EMA.

In total, 5 out of the 14 papers were completed and the results were published in whole or in part. One of the papers was discontinued and its results were deemed unpublishable. A brief description of the published research findings is given below:

- Hyperbaric Oxygen for COVID-19 Patients with Moderate or Severe Hypoxemia - a large study from the US (assumed number of subjects 360). The study assumed that hyperbaric oxygen therapy could reduce hospital mortality or the need for mechanical ventilation among COVID-19.
- Hyperbaric versus normobaric oxygen therapy in patients with COVID-19 - This was a Canadian multi-center study with other facilities in Canada, Switzerland, and the UK. The efficacy of hyperbaric versus normobaric oxygen therapy was assessed in patients requiring oxygen therapy for COVID-19.
- Safety and efficacy of hyperbaric oxygen in ARDS in patients with COVID-19. This was a planned study by a center in Germany and Sweden assuming the thesis that HBOT reduces mortality, increases tolerance to hypoxia and prevents organ failure in patients with COVID-19 pneumonia, and also reduces the need for intensive care in the ICU.
- The use of hyperbaric oxygen therapy according to the application of "Compassionate use". This was a retrospective study from the USA covering a 2-year period of observation of the use of HBOT as a program of "humanitarian use of drugs".
- Hyperbaric oxygen as an adjunct therapy in patients with severe hypoxemia caused by Covid-19. The study was stopped and (marked as completed) researchers from Argentina found that HBOT reduces mortality, increases tolerance to hypoxia and prevents organ failure in patients with COVID-19 pneumonia. The results were published in February 2022.
- The use of hyperbaric oxygen therapy in the treatment of COVID-19 patients with respiratory disorders. The study evaluates the use of hyperbaric oxygen therapy in the treatment of a group of 10 patients who were previously treated for COVID-19 in and underwent HBOT with those who did not receive hyperbaric oxygen therapy.
- Hyperbaric oxygen in people with longCovid having pulmonary complications after COVID-19. This was work conducted by American researchers, partially completed. It involves observations of patients who had Covid-19, in whom HBOT was used following the appearance of longCovid symptoms.
- Hyperbaric oxygen therapy in postCOVID-19 syndrome. The effect of HBOT treatment in patients with chronic COVID-19 and persistent pulmonary symptoms following SARS CO-2 infection was studied.

- Two works from Israel have already been completed and the results published. The first concerned the comparison of the effect of HBOT on patients with post-COVID-19 syndrome symptoms, and the second assessed the effectiveness of HBOT in patients with moderate COVID-19. In both cases, the results indicated the effectiveness and good effect of HBOT therapy in patients with COVID-19.
- Hyperbaric Oxygen Therapy for COVID-19 Patients and Hyperbaric Oxygen Therapy for Non-Ventilated COVID-19 Patients: Both studies were conducted in the United States. The studies have been completed and the results have been published. The first study evaluates the safety and efficacy of hyperbaric oxygen therapy (HBOT) as an experimental rescue treatment for patients with a disease other than COVID-19, and the second study evaluates the efficacy of hyperbaric and normobaric oxygen therapy in patients with laboratory-confirmed COVID-19 infection.
- Application of hyperbaric oxygen therapy in patients with hypoxic pneumonia with SARS-CO2 (COVID-19) - assessment of the effectiveness of HBOT as a supplement to normal treatment during the period of normalization of oxygen demand in patients with SAR-CO2 pneumonia not requiring invasive or non-invasive ventilation.
- In the field of safety and effectiveness of HBOT
- therapy, research was carried out in Sweden. The title of the project was: "Safety and effectiveness of hyperbaric oxygen therapy in long COVID syndrome". The main hypothesis of this work was that hyperbaric oxygen alleviates symptoms associated with long COVID. The hypothesis was verified positively.

The researchers' conclusions after completing their work are presented below.

Israel - the works come from one center and have been completed.

1. Hyperbaric Oxygen Therapy for Patients with COVID-19: A Prospective, Randomized, Controlled Trial. This study demonstrates for the first time in a prospective randomized clinical trial that HBOT is a safe therapeutic modality that can improve oxygenation, reduce inflammation, and improve the clinical condition of critically ill patients with COVID-19. Larger studies are needed to assess the effect on hospital mortality.

2. Hyperbaric oxygen therapy in post-COVID-19 syndrome Investigator Conclusions: Thirty-seven patients in the HBOT group and 36 patients in the control group completed the protocol and were included in the analysis. This is the first prospective, randomized, controlled trial to demonstrate significant improvement beyond the expected course of clinical recovery after COVID-19. The results indicate that HBOT improves, psychiatric symptoms (depression, anxiety and somatization), pain

interference symptoms and fatigue. [Hyperbaric oxygen therapy improves neurocognitive functions and post-COVID symptoms: a randomized controlled trial [10].

USA

Hyperbaric oxygen for COVID-19 patients
(Hyperbaric Oxygen for COVID-19 Patients)

Conclusions: Although limited by the study design, results demonstrate safety hyperbaric oxygen among COVID-19 patients and strongly suggest the need of well-designed, multicenter randomized controlled trial [3].

Table 4 presents 2 studies that were not included in the clinical trials database.

Tab. 4

Results of works not registered in the US National Library of Medicine and EMA databases.

Title	Country	Publication/research center	N	Results - description of therapy
Hyperbaric oxygen therapy for the treatment of long COVID: early evaluation of a highly intervention	UK	Robins T., Gonevski M., Clark C., Baitule S., Sharma K et al, Hyperbaric oxygen therapy for the treatment of long COVID: early evaluation of a highly. intervention Clin [11]. University Hospitals Coventry and Warwickshire NHS Trust, Coventry, UK, Warwick Medical School, Coventry, UK and Coventry University, Coventry, UK	10	Study 10 longCovid patients were treated with HBOT. Fatigue is the most common symptom reported. Interventional treatment options are limited. Presents the first evaluation of hyperbaric oxygen therapy for long-term COVID treatment. 10 HBOT sessions to 2.4ATA over 12 days. Each treatment session lasted 105 minutes and consisted of three 30-minute exposures to 100% oxygen. Results show potential benefits of HBOT, with results being statistically significant after 10 sessions.
Hyperbaric oxygen treatment for long coronavirus-19: a case report	EA and IZ	Bhaiyat A. M., Sasson E., Wang Z. et al. Hyperbaric oxygen treatment for long coronavirus disease-19: a case report [12]. - Aviv Clinics, Jumeirah Lake Towers, Dubai, United Arab Emirates - Sagol Center for Hyperbaric Medicine and Research, Shamir Medical Center; Israel Sackler School of Medicine and Sagol School of Neuroscience, Tel Aviv University, Tel Aviv, Israel	1	The first case of successful treatment of long-term COVID symptoms with HBOT with improved cognitive and cardiorespiratory function is presented. The beneficial effects of hyperbaric oxygen shed additional light on the pathophysiology of chronic Covid. A 55-year-old female patient was referred for hyperbaric therapy in April 2021 - 3 months after recovering from COVID. The therapy consisted of 60 sessions of 90 minutes each with 100% oxygen in 2 absolute atmospheres with 5-minute breaks for air for 20 minutes, 5 days a week. As this is a single case report, further prospective randomized controlled trials are needed

Source: Own study.

The first paper comes from the UK. It assessed a group of 10 LongCovid patients undergoing HBOT, in which the results suggested a potential benefit from HBOT.

The second paper describes a single case of a LongCovid patient successfully treated with hyperbaric oxygen therapy with improved cognitive and cardiorespiratory function. The paper is described by researchers from Israel and the United Arab Emirates as a preliminary report.

MANIPULATION OF KNOWLEDGE, OR COVID-19 AND LONGCOVID SYNDROME THERAPY IN SOFT CHAMBERS

An important aspect in science is unfortunately the possibility of manipulating knowledge, by using the results of research conducted by research centers to advertise oxygen therapy treatments (the adjective hyperbaric was deliberately not used here) using so-called soft chambers. On many websites, you can find false information regarding the possibility of treating longCovid in soft hyperbaric chambers [13]. The information is presented as clinical recommendations and even research results with bibliography are included. The alleged effectiveness of the therapy encourages patients to use treatments in soft chambers. The low cost of those chambers (compared to mono and multiplace chambers - with a hard casing adapted to high pressures) makes them increasingly popular. These chambers (are not

registered) and no permits are required for their use. They are often combined with oxygen concentrators and oxygen is administered through a mask or, even worse, through open pipes (flow type), where oxygen flows into the chamber lumen resulting in a fire hazard.

It is worth adding that in the USA, these types of chambers are not recognized as therapeutic chambers and are not registered for medical procedures, except for therapy for high-altitude sickness. These chambers are essentially a Gamow bag, in which the pressure does not exceed 1.3 - 1.4 ATA. The Main World Society of Hyperbaric Medicine (Undersea and Hyperbaric Medical The Society defines hyperbaric oxygen therapy as breathing oxygen delivered at pressures greater than 1.4 ATA. The indications for HBOT require that the patient breathe 100% oxygen while in a chamber at a pressure of at least 1.5 atmospheres absolute. Low-pressure fabric chambers are not designed to deliver this clinical dose of oxygen and pressure. According to Jim Bell, CHT/EMT/CFPS, Chairman of the UHMS HB02 Safety Committee, and Tom Workman, MS, CAsp.CHT, FAsM, UHMS Director of Quality Assurance and Regulatory Affairs, clinical hyperbaric oxygen chambers should be designed to be manufactured, stored, and operated in accordance with FDA, NFPA, and ASME-PVHO codes [14].

Canada also issued a warning on its official government website regarding the use of unauthorized soft hyperbaric chambers and introduced a ban on their use [15].

It should be emphasized that this type of manipulation of medical knowledge regarding the nature

of the pressure used or the method of oxygen administration is not only dangerous to the health and life of patients but is also unethical. The combination of media reports about the post-covid consequences (such as LongCovid) with the miraculous recipe of using a chamber with soft walls and an oxygen concentrator "supported" by encouragement and advertising - give the impression of therapeutic activities - which they are absolutely not. No such "therapy" and in such chambers has received a positive recommendation from the scientific community, and patients should be warned about all the potential effects and risks of this type of "therapy" [16,17,18,19,20,21,22,23].

SUMMARY

The interest in HBOT for COVID-19 and longCOVID is understandable for both researchers and clinicians. The emerging questions about the recommendations of the therapy by the Scientific Societies are also obvious. As a result, in April 2020, ECHM and EBUS issued further recommendations on the use of HBOT in the treatment of COVID-19 and post-COVID rehabilitation after the Consensus Conference. The

Scientific Societies are inclined to the thesis that the use of HBOT in COVID-19 patients outside of a scientific study can ONLY be implemented after a careful balance of benefits and risks for each specific patient, taking into account the lack of possible alternative treatments and recognizing that HBOT may be harmful by withholding / interrupting necessary supportive treatments or exposing staff and other patients to the risk of SARS-CoV2 infection.

The review of the scientific databases of research works allows for three statements:

- there is a need for further randomized studies on a larger population with control groups.
- It can be stated that based on such few published scientific papers and a relatively unrepresentative research group, it is difficult to clearly issue recommendations or a ban on the use of HBOT in COVID-19 or longCovid syndrome.
- It is also necessary to educate society about the use of HBOT in accordance with the recommendations of Scientific Societies and to counteract the manipulation of medical knowledge.

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dr n. med. Gabriela Henrykowska
Zakład Epidemiologii i Zdrowia Publicznego,
Uniwersytet Medyczny w Łodzi
gabriela.henrykowska@umed.lodz.pl