Electronic Repository of Educational Materials on the Topics "Rehabilitation in Post-COVID" and "Neurorehabilitation in Neuro-COVID": Structure of the Course and Analysis of Learners' Opinion

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Abstract. The pandemic of COVID-19 imposed the necessity to develop the competences of medical specialists and health professionals on the topic "COVID-Rehabilitation". We prepared educational materials and an electronic repository, including these topics. The current article presents the structure of the course and the learners' opinion on the benefits of the educational module.

Keywords: Electronic Repository, E-book, Rehabilitation, Neurorehabilitation, COVID-19, Post-COVID, Long-COVID, Neuro-COVID.

1 Introduction

1.1 Coronavirus Disease

The pandemic of coronavirus disease (COVID) -19 provoked many health problems in all countries, including Bulgaria. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) includes symptoms with diverse levels of severity of different systems: respiratory, cardiovascular, nervous, etc. (World Health Organization, 2020).

All these symptoms altered the quality of life of patients. In every clinical case, rehabilitation is needed – during or after the acute stage, and in cases of sequelae of severe and critical forms of COVID: respiratory alterations, cognitive and neurological disorders; deconditioning; critical illness-related myopathy and neuropathy; dysphagia; joint stiffness and pain; psychiatric problems (World Health Organization, 2022).

1.2 Physical and Rehabilitation Medicine

According to the definition of the European Union of Medical Specialists, Physical and Rehabilitation Medicine (PRM) is an „independent medical specialty, oriented to the

promotion of physical and cognitive functioning"; responsible for the management of the prevention, diagnostics, treatment and rehabilitation of patients with health-related disability and co-morbidity of all ages. The White Book on Physical and Rehabilitation Medicine formulates the basic objective of PRM: optimization of social participation and the amelioration of the quality of life of patients (Gutenbrunner C, Ward AB, Chamberlain MA., 2007), (European PRM Bodies Alliance, 2018).

The World Report on Disability defines the goals of rehabilitation: prevention of the loss of function; slowing the rate of loss of function; improvement or restoration of function; compensation for lost function; maintenance of current function (World Health Organization and the World Bank, 2011).

1.3 COVID-rehabilitation

During the COVID-19 pandemic, rehabilitation was based on recommendations of the Pan American Health Organization (PAHO) and the World Health Organization (WHO). The document of PAHO and WHO, entitled "Rehabilitation considerations during the COVID-19 outbreak", communicated rehabilitation procedures in the *management of patients with severe COVID-19;* and *for the continuity of rehabilitation for non-COVID-19 patients* (PAHO & WHO, 2020).

In January 2021, the WHO published recommendations for clinical management during COVID-19, including rehabilitation for patients with COVID-19 (World Health Organization, 2021); (World Health Organization, 2022). Rehabilitation interventions begin during the acute stage and continue after hospital discharge – in the post-acute phase and during long-term treatment. In severe-critical cases, many impairments are observed: respiratory dysfunction, physical deconditioning, and weakness, impaired communication and swallowing, cognitive problems, anxiety and depression, and difficulty-managing activities of daily living (ADLs).

Rehabilitation programs must include: exercises, education on self-management strategies, respiratory techniques, assistive products, home modification, treatment of complications, and psychological support. For ambulatory patients, we apply physiotherapy and ergotherapy (occupational therapy), oriented to the management of breathlessness and ADL. We accentuate on respiratory exercises, exercises for range of motion and strengthening exercises – for extremities.

1.4 Neurological Complications of COVID-19. Neurorehabilitation in Neuro-COVID. Robotics.

Neurological manifestations of coronavirus are considered a public health emergency of international concern (European Center for Disease Control, 2021).

The monograph of Marco Cascella and Elvio de Blasio "Features and Management of acute and chronic Neuro-COVID" summarizes the information on the topic of neurological consequences of COVID-19. The term Neuro-COVID includes signs and symptoms of the central nervous system (CNS), peripheral nervous system (PNS), skel-

etal muscle manifestations; psychological and psychiatric acute problems. Authors divide Neuro-Covid into acute conditions and long-term effects of Neuro-COVID (Cascella M, De Blasio E., 2022).

Elements of the PRM algorithm or neurorehabilitation (NR) algorithm include: kinesitherapy (KT: exercises, massage), preformed physical modalities (electric currents, magnetic field, light), ergotherapy (ET: activities of daily living), thermo/balneo/peloido-therapy (paraffin, mineral waters, therapeutic mud, fango), patient education (medicaments, physical activity, diet, control of risk factors) (Koleva, 2008).
Ultimately, contemporary information and communication technologies (ICT) were introduced in the rehabilitation practice (Aprile I, Germanota M, Cruciani A et al., 2020). We use Exoskeletons, virtual reality, and robotic rehabilitation with Lokomat (Hocoma system for balance and gait training) and ThyroMotion system (for grasp training).

1.5 Electronic Education, Digitalization of Educational Materials, Electronic Libraries, and Repositories

During the COVID outbreak, electronic education was introduced in various universities (Monova - Zheleva M, Zhelev Y, 2018). Students and trainees accepted easily the online courses and digitalization of educational resources (Paneva-Marinova D, Pavlov R, 2018). Some elements of e-learning remain in the educational practice, especially online lectures, application of digitalized educational material, e-books and e-repositories, online tests for the evaluation of competencies and for assessment of learners' opinions.

2 Exposition of the Investigation

2.1 Objectives and Phases of the Investigation

Our goal was to prepare educational materials on the topic "COVID-rehabilitation". During the working process, we emphasize the topics: "Rehabilitation in post-COVID" and "ICT-based neurorehabilitation in neuro-COVID".

Our study included several phases: a review of the scientific literature, including electronic media; choice of the principal chapters; an exposition of the material; choice of clinical cases for illustration; construction of the educational module; application of the material in the educational process of different types of learners; evaluation of students' competencies at the end of the educational module; assessment of learners' opinion.

2.2 Structure and Contents of the Educational Materials

The repository used the educational platform of the Medical University of Sofia. Users are our students and trainees, invited to access the platform. We put inside two electronic books, some articles on these topics and video-films of some of our patients.

The first part of the educational module "COVID-rehabilitation" was divided into several principal chapters and sub-section, presented in Figure 1 (Koleva I., Yoshinov B., Yoshinov R., Asenova T., 2022).
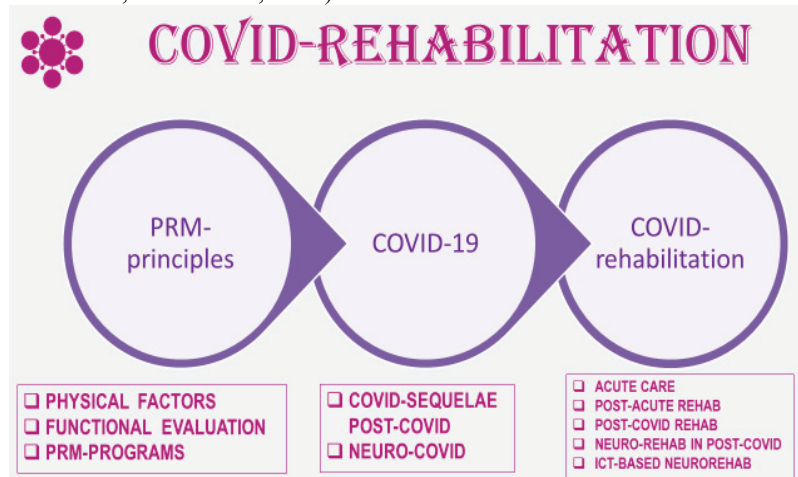

Fig. 1. Principal chapters in the educational module "COVID-rehabilitation".

In the **first chapter**, we explain the principles of the specialty of Physical and rehabilitation medicine (PRM). Modern rehabilitation has an integrative and holistic approach to the patient, based on the International Classification of Diseases; the International Classification of Functioning, disability and Health, and on clinical principles (WHO, 1992); (WHO, International Classification of Functioning, Disability and Health., 2001). The complex PRM algorithm includes a detailed functional assessment of the patient (emphasizing goniometry, manual muscle test, grasp and gait evaluation, autonomy in everyday activities, ICF evaluation, pain measurements) (Koleva I & Avramescu T Editors, 2017), and a complex rehabilitation program, established by a synergic combination of different natural and preformed physical modalities (kinesiotherapy and ergotherapy, cryo and peloido-procedures, electrotherapy and photo-therapy, magnetic field, etc.). The synergy between different physical modalities is the logical base for the prescription of complex PRM programs, including different physical modalities: *one or two pre-formed modalities; one thermo- or cryo-agent; one or two physiotherapeutic procedures* (including soft tissue techniques, e.g. massage, stretching, post-isometric relaxation; manual therapy; analytic exercises, etc.). At the end of every rehabilitation course, it is obligatory to realize a functional assessment – with the goal to evaluate the efficacy and to prescribe consecutive rehabilitation procedures.

Second chapter is dedicated to the clinical specificity of the Corona-virus-disease (COVID-19). During the acute stage, the most common symptoms are: fever, cough, fatigue, shortness of breath, myalgias, etc. In critical cases, patients may have acute respiratory distress syndrome (ARDS), sepsis or septic shock. Many complications can occur: respiratory failure, thromboembolism (deep vein thrombosis, pulmonary embo-

lism), multi-organ failure (acute kidney or cardiac injury), acute cerebrovascular disease (ischemic or haemorrhagic stroke), Guillain-Barré syndrome, meningoencephalitis (World Health Organization, 2021), (World Health Organization, 2022).

During the last year, post-COVID syndrome or long-COVID-19 was described. The most frequent symptoms are: fatigue; difficulty breathing, cough; joint and muscle pain; memory, concentration or sleep problems; brain fog or inability to concentrate and impaired memory; post-traumatic stress syndrome, depression and anxiety; loss of taste and/or smell, etc.

The clinical spectrum of coronavirus induced-disease includes the continuum from oligo- and paucisymptomatic forms to different degrees of respiratory insufficiency and multi-systemic dysfunction until multi-organ failure. Extrapulmonary manifestations are: hematologic, cardiovascular, gastrointestinal, and neurological.

The **third chapter** includes principles of rehabilitation in acute, post-acute, and chronic stages of COVID-19.

The clinical **CARE** pathway includes four steps: *C* – confirmation of the SARS-CoV-2 infection, *A* – assessment of symptoms, risk factors, and severity of the disease, *R* – response with appropriate care and treatment, and *E* – evaluation of the clinical response and recovery (World Health Organization, 2021).

The second part of the repository is oriented to neurological complications of COVID-19, neuro-rehabilitation (NR) in neuro-COVID and ICT-based NR. The contents include the second e-book, articles, case reports with video-films (Koleva I, Yoshinov B, Yoshinov RR, 2022).

Neuro-COVID includes signs and symptoms of the nervous system - central (CNS) and peripheral (PNS), skeletal muscle conditions and long-term sequelae (Cascella M, De Blasio E., 2022). **CNS manifestations** comprise: *Headache* (tension-type or migraine); *Dizziness* (combined with headache and tinnitus); *Acute encephalopathy* (delirium or decreased level of consciousness up to coma); *Posterior reversible encephalopathy* (altered consciousness, seizures, headaches and visual disturbances); *Seizures* (focal motor, tonic-clonic, convulsive and non-convulsive status epilepticus); *Acute cerebrovascular diseases* (ischemic stroke, cerebral hemorrhage, cerebral venous thrombosis); *Meningitis and encephalitis* (tension-type or migraine); *Acute myelitis* (mostly transverse myelitis, with different degrees of paresis, up to quadriplegia or paraplegia, plus sensitive and sphincter dysfunction). **PNS manifestations** include: *Smell and taste impairment* (hyposmia, anosmia, parosmia, olfactory hallucinations); *Guillain – Barré syndrome* (ascending flaccid paralysis with areflexia/hyporeflexia, sensory deficits); *Pain* (headache, muscle / joint pain, chest and abdominal pain); *Cranial nerve injuries* (ophtalmoparesis, facial nerve palsy – unilaterally or bilaterally). **Skeletal muscle manifestations** are: *Asthenia and Myalgia* (muscle pain, joint pain/arthralgia); *Skeletal muscle injury* (myalgia combined with increased serum creatinine kinase levels) – up to rhabdomyolysis. ***Long-term effects*** contain *neurological sequelae* (fatigue, muscle weakness, sequelae of stroke and demyelinating polyneuropathies); *psychological effects* (anxiety, depression, affective disorders, sleep issues, post-traumatic stress syndrome), and *neurocognitive issues* (e.g. brain fog).

The second part of the repository is based on our electronic book "Neuro-rehabilitation in neuro-COVID" (Koleva I, Yoshinov B, Yoshinov R, 2023), we explained the

principles of neurorehabilitation (NR) in these cases, including robotic NR. We included clinical examples of patients of our practice, treated by robotic rehabilitation (Figure 2).

The term robot was coined and popularized by Karel Čapek (in the play R.U.R. or Rossum's Universal Robots, 1921) and is derived from the Czech word "robota", meaning work, hard work, worker. Karel Čapek himself wrote in a letter that the author of the word was his brother Josef Čapek, an artist and writer (Gür, n.d.). The word "robota" means work in many Slavic languages, as archaic Czech, Slovak, Bulgarian, Russian, Serbian, Polish, Ukrainian, etc. It is considered that the word derives from the reconstructed proto-slavic word "rabota", meaning "work, hard work, obligatory work for the king" (Robot, n.d.)

The Robot Institute of America defined a robot as "a programmable, multi-functional manipulator designed to move material, parts or specialized devices through variable programmed motions for the performance of a variety of tasks" (Xie M., 2003). The common tasks of a robot are defined as the *three Ds: dull, dirty, and dangerous*; consequence of the necessity of repetitive movements and weight-support of patients in NR clinical practice (Lin P, Abeny K, Bekey GA., 2012). Robots help rehabilitation staff in the process of control and measurements of patients' movements (Huang V, Krakauer J, 2009).

In this part, we presented clinical cases with neurological complications of COVID-19, as follows: cerebral vascular accidents, spinal ischemic stroke, relapses of multiple sclerosis, Guillain-Barre syndrome, development of rare diseases (such as cerebellar ataxia or amyotrophic lateral sclerosis /motor neuron disease/), etc. (Koleva I, Yoshinov B, Yoshinov RR, 2022). Our results demonstrated the positive effects of ICT-based NR on neuroplasticity, functional recovery, and quality of life of these patients (Figure 3).
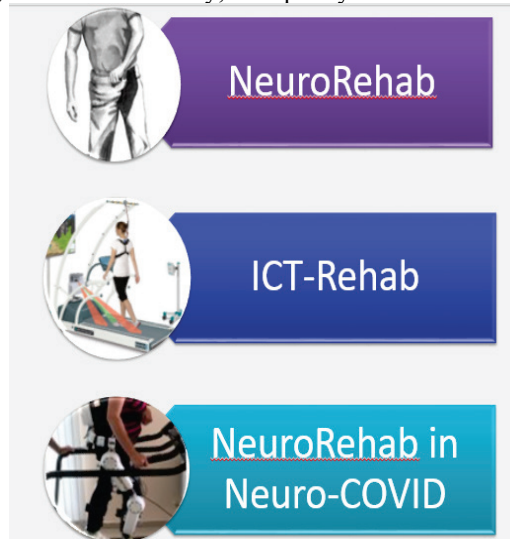

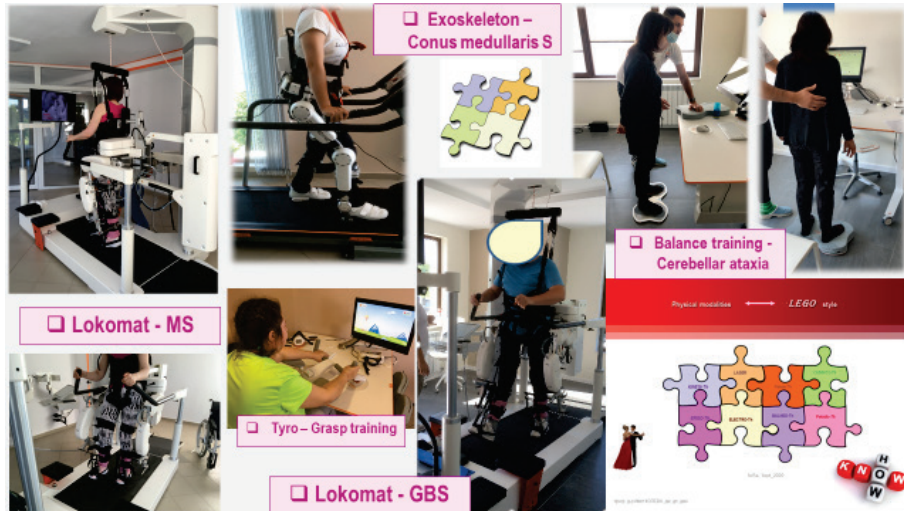**Fig. 2.** Elements in the educational module "Neuro-Rehabilitation in Neuro-COVID".

Fig. 3. Cases - ICT-based NR in Neuro-COVID.

2.3 Investigation of the Efficacy of the Educational Materials

Last year (summer semester of 2022 and winter semester of 2022/2023) we introduce these modules in the educational courses of different types of learners: students in bachelor's degree (Physiotherapy, Nursing, Midwifery, Medical assistants, Medical rehabilitation and Ergotherapy) and Master's degree (Medical rehabilitation and Balneotherapy), and learners during long-life learning courses (physiotherapists and medical doctors – trainees in "Physical and Rehabilitation medicine").

We used the electronic repositories for the preparation of our learners and we evaluated professional competencies after the introduction of the electronic materials. We investigated the learners' opinions on the educational materials, using a Likert scale of 7 levels.

3 Analysis of Learners' Opinions on the Efficacy of the Application of the Electronic Repository

As mentioned before, we applied the educational materials in the courses of our students and trainees and we investigated their opinion.

For statistical analysis of results, we used the statistical package SPSS.

3.1 Structure of the Responders

The structure of the responders is presented in Table 1 and Figures 4 and 5.

Table 1. Distribution of responders by profession / future profession.

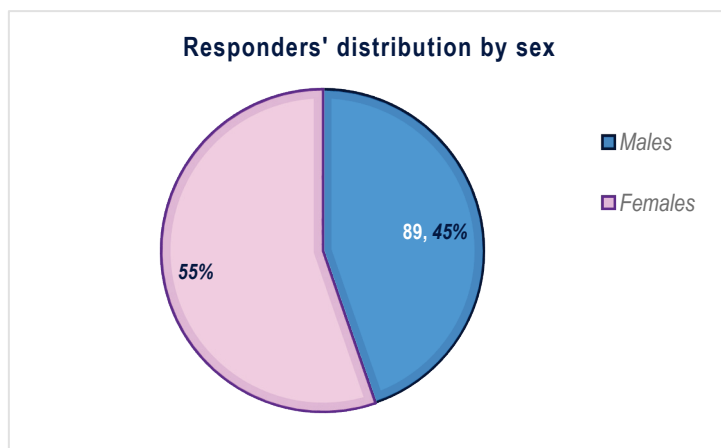|	KT	Nurses	Midwives	Med_assist	MRET	MRB	MD
Bachelors	37	76	18	14	36		
Masters						11	7
			181			18	
Total			199				

Fig. 4. Responders' distribution by sex.
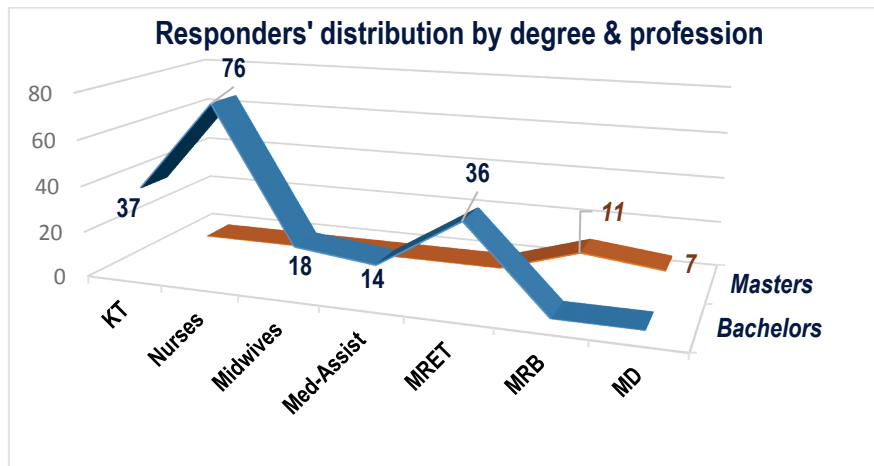
Fig. 5. Responders' distribution by educational degree and profession.

3.2   Results

For the investigation of the learners' opinions, we applied a Likert scale of 7 levels: Strongly positive, Positive, Maybe Yes, Indifferent, Maybe no, Negative, and Strongly Negative. Results are presented in table 2 and Figure 6.

Table 2. Distribution of opinions of the responders.

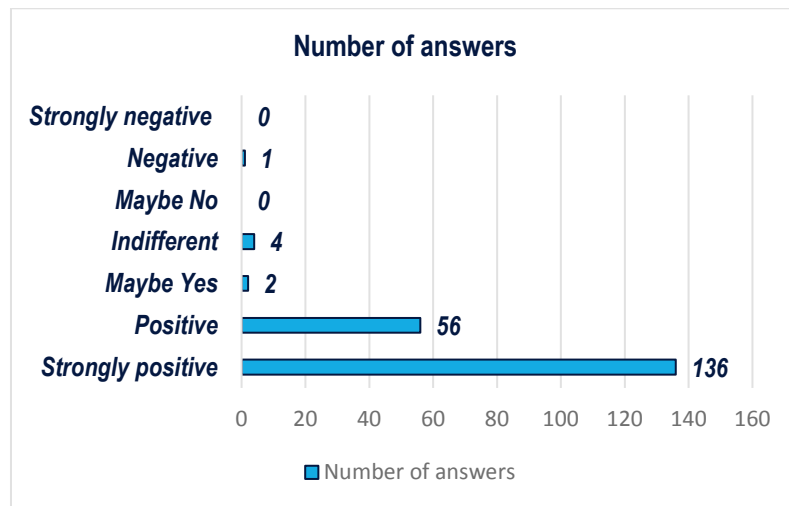| Learners' opinion	Number of answers	Percent
Strongly positive	136	68.34 %
Positive	56	28.14 %
Maybe Yes	2	1.005 %
Indifferent	4	2.01 %
Maybe No	0	0
Negative	1	0.50
Strongly Negative	0	0

Fig. 6. Responders' opinion.

4   Conclusions

Learners consider very important the topics "Rehabilitation in post-COVID" and "ICT-based neurorehabilitation in neuro-COVID". Their opinion of these educational materials and the electronic repository is predominantly positive. They consider useful the creation of these educational modules.

In the future, the creation of digitalized materials in the field of rehabilitation must be amplified.

Acknowledgements.

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