



REHABILITATION OF COVID-19 PATIENTS

The coronavirus-2 (SARS-CoV-2) pandemic has dramatically transformed the organization of public and private health organizations of the Lombardy region, the Italian region where the viral spread has been more quick and intense (1). According to the data available on the 8th of April 2020 from the beginning of the epidemic at the end of February, 139,422 cases and 17,669 deaths have been reported in Italy, which may underestimate the real incidence.

The rapid spread of the virus has upset all hospital organizations. The Rehabilitation Hospitals, as well as the rehabilitation units of multidisciplinary institutes, have considerably changed their activity. The need for medical assistance to an increasingly higher number of patients forced the hospitals to improve the volume of intensive care beds and to convert the rehabilitation departments in COVID-19 beds.

San Raffaele Scientific Institute, a large tertiary hospital and research centre in Milan, Italy, was immediately involved in the management of the public health emergency (1).

After the first COVID-19 case of San Raffaele Scientific Institute of Milan, dated back on 25th February, the 3 Rehabilitation Units were merged to create dedicated beds for coronavirus cases in less than one week.

Furthermore, regional laws relieved the outpatient activities of the Rehabilitation Departments to reduce the viral spread. The nurse staff have been sent to the new COVID-19 Rehabilitation Department created for those patients coming from the Intensive Care Units. At this moment, about 40 patients are hospitalized in the Rehabilitation Department at San Raffaele Hospital.

The acute respiratory syndrome caused by SARS-CoV-2 syndrome may be characterized by mild respiratory diseases or moderate-to-severe pneumonia, which can cause Acute Respiratory Distress Syndrome (ARDS) and multi-organ failure.

In SARS-CoV-2 pneumonia, bilateral interstitial infiltration with serious alteration of the ventilation-perfusion ratio and probably shunt, cause hypoxic respiratory insufficiency (2).

Acute hypoxemia may cause obstinate dyspnoea with the need of oxygen therapy administration through High-flow nasal oxygen (HFNO), or through the application of a non-invasive positive pressure, c-PAP or NIV (with oronasal or face masks, helmets) (2, 3). Unfortunately, in case of O₂ saturation worsening, orotracheal intubation and invasive mechanical ventilation are mandatory.

The pulmonary parenchyma presents focal haemorrhages and necrosis, even up to a haemorrhagic infarction. The alveolar exudate can consolidate causing

pulmonary fibrosis. However, SARS-CoV-2 infection does not only affect lungs. The spleen is reduced, with bleeding and focal necrosis. Lymphocytes count significantly decreases because of necrosis and macrophages proliferate with phagocytic phenomena. On immunohistochemical tests, spleen and lymph nodes show CD4+ and CD8+ T-lymphocytes reduction. In the bone marrow, the cells of all 3 lines (erythroid, myeloid and megakaryocyte) are reduced in number. Serious primary cardiovascular injury is also reported: cardiomyocytes can show degenerations and necrosis, lymphocytic or neutrophil interstitial infiltration has been observed and vessel disepithelialisation, vasculitis, and micro-thrombi formation. The liver and kidneys are also affected in COVID-19 patients: hepatocytes degenerate, liver sinusoids are hyperaemic with micro-thrombi and lymphocyte and neutrophil infiltration of the portal spaces; while tubules show epithelial degeneration and capillary of the interstitium are hyperaemic, with possible micro-thrombi and interstitial fibrosis.

Central nervous system involvement has also been reported, with dysgeusia, hyposmia and consciousness alterations or neuropsychological manifestations. The brain parenchyma shows hyperaemia and oedema with neuronal degeneration (4). The haematogenous spread seems to be responsible for the “neuroinvasion” of SARS-COV-2 with the involvement of the central and peripheral nerve pathways. Consequences are the Critical Illness Myopathy and Neuropathy, (CRIMINE), as well as other possible neurological syndromes with post-infectious aetiology, such as Guillain-Barré syndrome (4).

To date, two distinct phases of SARS-CoV-2 syndrome have been identified: the first acute phase is characterized by a prevalent respiratory syndrome, while in the second one, together with the progressive recovery of the respiratory disease, prolonged bed rest syndrome and invasive mechanical ventilation sequelae have been reported.

Based on the aforementioned features, rehabilitation of COVID-19 patients cannot be separated from the medical assistance, for respiratory, infective or neurological issues which, together with bedsores, peripheral muscle weakness, muscular retractions, articular limitations, balance/postural disorders, and physical deconditioning caused by prolonged bed rest, could dramatically reduce the chances of returning to a pre-infection functional status (5).

These aspects deeply influence the rehabilitation care of these patients and the characteristic of the medical team. Indeed, the recent SARS-CoV-2 experience has revealed the need for a multidisciplinary rehabilitative

approach, especially for those patients with serious COVID-19 illness, advanced age, obesity, multiple chronic diseases, and organ failure. Every patient needs a neuromotor and respiratory rehabilitation program, tailored based upon the aforementioned features.

As already mentioned, the recovery of COVID-19 patients aims at improving the respiratory function, counteracting immobilization, reducing the rate of long-term complications and disability and to improve cognitive and emotional domains, in order to promote the quality of life and facilitate the discharge at home (6).

The rehabilitation management of SARS-COV-2 patients is also related to the two stages of the infection mentioned above. In the acute phase, mainly characterized by respiratory disorders, early respiratory rehabilitation is highly recommended. Relevant physiotherapy aspects are the multidisciplinary management of non-invasive ventilation, frequent changes of posture, passive mobilization, positional therapy and recovery of motor function once the acute phase has been resolved. Regarding postural management, it is important to gradually increase the anti-gravity position based on the patient's clinical condition, until the patient can maintain an upright position. It can be also useful to keep patients in a semi-sitting position, with the bed backrest at 45–60°. According to their clinical conditions, patients have to undergo orthostatism and postural variation treatments several times a day (7). It has to be noted that patients suffering from ARDS take advantage from prolonged prone ventilation, even more than 12 h/day (8).

Neuromotor rehabilitation is a key concept of recovery from immobilization syndrome. Passive/active mobilization, muscle strength, and articular recovery, assisted training even if only primarily in sitting position, are essential to create the basis for starting a complete rehabilitation program as soon as the infectious phase is over. Isolation is effective to reduce the spread of SARS-CoV-2, but it also represents a severe limitation of patients' movement, which increases the possibility of immobilization syndrome, especially in case of fever, fatigue and muscles pain. All these issues can lead to muscular strength decrease, insufficient sputum drainage, increased risk of deep vein thrombosis and bedsore, as well as neuropsychological issues, such as anxiety, depression and lack of motivation.

Together with pure physiotherapeutic management, other clinical aspects have to be considered. The first concerns the swallowing function. Invasive mechanical ventilation needed in a percentage of COVID-19 patients can lead to post-intubation iatrogenic dysphagia (9). Many patients may undergo nasogastric feeding and the progressive return to normal feeding requires an assessment of dysphagia and eventually targeted

treatments by specialized rehabilitation professionals, such as the speech therapist and physiotherapist. A second aspect concerns the cognitive functions. Long ICU period and anoxic damage can lead to anxiety, post-traumatic stress disorder, and depression or in more serious and especially elderly cases, to cognitive functions decline. Neuropsychological support represents a fundamental activity, which has to be included in the rehabilitation programs of these patients.

Dysphagia and alterations of cognitive functions in COVID-19 patients are still being evaluated however, their presence in a large number of hospitalized patients suggests, as well as in other neurological conditions, that their management is fundamental for social reintegration.

All these therapies have to be performed at the patient's bed. Personal protective equipment is mandatory. However, their shortage, which was promptly declared by health structures managing COVID-19 patients, caused many infections among health professionals, about 10% of overall cases, with consequent difficulty in health management.

Considering the clinical conditions caused by prolonged immobilization and musculoskeletal deterioration, these patients need rehabilitation treatments also after COVID-19 unit discharge. Particularly, those cases still experiencing respiratory or motor problems have to continue their rehabilitation programs in Specialist Rehabilitation units to improve the chances of recovery, while those case with few and minor sequelae of COVID-19 infection, may undergo home or outpatient rehabilitation therapy, mainly aimed to restore motor skills and to promote psychological recovery. In both cases, the rehabilitation program has to be focused on each impairment area specific for each patient (10):

- Aerobic exercise: for those cases with respiratory/motor problems and physical deconditioning;
- Strength training for peripheral muscle weakness;
- Static and dynamic balance training for balance dysfunction;
- Bronchial clearance techniques: in hypersecretive patients, training in techniques favouring secretions removal is recommended;
- Evaluation of Basic Activities of Daily Life (BADL): evaluation of patients' ability to carry out daily activities and eventually improve recovery or adaptation to them, with the support of physiotherapists and occupational therapists;
- Neuropsychological training: counselling sessions, psychological support, and cognitive training.

This health emergency and the resulting adaptation of healthcare facilities, has negatively influenced the rehabilitation treatments of non-COVID-19 pathologies.

The delay of post-stroke rehabilitation, which early start strongly correlates with the best clinical and functional recovery, or bone fractures rehabilitation with prolonged immobility, are related to poor functional recovery with possible development of algodystrophic complications.

To date, restrictive measures have been taken to minimize contamination of the population and prevent a collapse of healthcare facilities.

We strongly hope in a close end of the COVID-19 outbreak and to return normal activity soon, however the actual situation still will influence the organization of the health care workers for the next months.

We thank deeply all colleagues who are fighting every day to provide the best care to COVID-19 patients.

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