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Letter to the editor

The role of physical and rehabilitation medicine in the COVID-19 pandemic: The clinician's view

Dear Editor,

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and the consequent coronavirus disease 2019 (COVID-19) are spreading all over the world, with human, economic and health consequences that are, at present (April 12th, 2020), still difficult to fully predict. The Chinese Centre for Disease Control recently published data on 44,672 patients infected with SARS-CoV-2 [1], showing that 88% of patients were < 70 years old, with an overall mortality rate of 2%, but 19% of cases needed hospitalisation in an intensive care unit (ICU). In a Chinese cohort of 191 adult COVID-19 patients who required hospitalisation [2], 61% needed ICU treatment, with a mean length of stay of 3 weeks.

The proportion of patients with COVID-19–related disability will be rapidly growing, and a prompt response from physical medicine and rehabilitation (PMR) specialists is crucial to reduce disability and help re-establish and optimise the function of the acute hospital setting.

COVID-19 has different clinical features, and a shared classification is not yet available. The most common forms are:

1) mild: no dyspnea, no low blood oxygen saturation ($SatO_2$);
2) moderate: dyspnea, $SatO_2$ 94% to 98%, radiological signs of pneumonia;
3) severe: dyspnea, $SatO_2 \leq 93\%$, respiratory rate (RR) > 30/min, radiological progression of lesions, with O_2 supplementation required, eventually with non-invasive ventilation;
4) critical: patients need mechanical ventilation.

Usually, patients with limited symptoms recover completely without any long-term sequelae. However, for patients with mild and severe or critical forms, consequences of COVID-19 can affect several systems.

In our clinical experience, the main repercussions are respiratory, central nervous system (CNS) and cognitive, deconditioning, critical illness-related myopathy and neuropathy (CRIMYNE), dysphagia, joint stiffness and pain, and psychiatric problems. Here, we describe these consequences and any rehabilitation, along with the organisation and functioning of PMR services due to the pandemic.

For respiratory consequences, in a prospective study of 97 SARS survivors, at 1-year follow-up, 24% had both significant diffusion of lung carbon monoxide and reduced exercise capacity [3]. However, in this study, only 6 patients required mechanical ventilation. Some patients, after severe and critical COVID-19, show persistent dyspnea, which can be present at rest, on passive mobilisation or only under effort. Persistent low $SatO_2$ (at rest or during passive or active mobilisation) has also been reported and usually can be associated with worsening dyspnea. Patients with persisting dyspnea and/or low $SatO_2$ after the acute phase could probably be those at increased risk of long-term sequelae such as lung fibrosis. Rehabilitation of patients with lung fibrosis secondary to acute respiratory distress syndrome (ARDS) is challenging. We have little evidence about the efficacy of specific rehabilitation techniques. We suggest the treatment that is usually recommended in primary lung fibrosis, published in 2013 by Kenn et al. [4].

For CNS and cognitive sequelae, a recent, retrospective study showed that survivors of severe and critical COVID-19 might have various neurological manifestations [5]. Clinical experience from Italy shows that after critical COVID-19, some patients may have memory and executive function deficits, and older patients with the severe type can also have confusion and executive problems [6] due to a direct viral involvement of the CNS [7] or the effect of hypoxemia. A report of COVID-19-associated encephalitis [8] suggested that patients with persistent altered mental status should probably undergo a neuroradiological examination. Considering that nearly 50% of ARDS survivors showed cognitive sequelae at 2 years after the injury [9] and that these deficits could play a significant role in overall disability, a bedside screening of executive functions and memory is highly recommended. We recommend screening patients using quick tests such as the Montreal Cognitive Assessment and Frontal Assessment Battery.

For deconditioning consequences, Ong et al. found that most SARS survivors showed reduced exercise capacity that could be due to not just limited impairment of pulmonary function [10]. From our experience, we recommend monitoring heart rate, RR and $SatO_2$ during exercise, especially in the early phases.

For CRIMYNE, we lack published evidence in COVID-19 patients. Mao et al. [5] reported anosmia and ageusia as manifestation of the disease affecting the peripheral nervous system. However, clinicians in Italy and France are reporting CRIMYNE manifestations associated with COVID-19. These are mainly myopathic forms, with severe muscle wasting, and, less frequently, peripheral axonal neuropathy (polyneuropathy or multiple mononeuropathy) of lower and upper limbs.

For dysphagia, post-extubation dysphagia has been reported in 3% to 62% of patients requiring mechanical ventilation for ARDS [11]. The pathophysiological mechanisms of dysphagia can vary in patients with COVID-19, and mechanical causes, diminished proprioception, laryngeal injury and peripheral or CNS damage have been proposed. Therefore, screening for dysphagia is mandatory in critical COVID-19 after extubation and should probably also be performed in older patients with severe forms.

For joint stiffness and pain, immobilisation and joint stiffness are frequently associated, mainly in older patients. So, this issue can be observed in older patients with moderate to severe COIVD-19 forms and in younger adults with critical forms.

For psychiatric problems, during the SARS epidemic, most frequently reported psychiatric problems (for patients, relatives and healthcare workers) were anxiety, depression, fear and anger

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as well as post-traumatic stress disorder. In critical and severe COVID-19, a psychiatric complication is differentiated from delirium due to the effect of hypoxia, brain lesions, and corticosteroids, and, for older patients, isolation could be difficult. We recommend starting at different levels. First, hospitals and PMR services should provide a regular communication plan to healthcare workers, to avoid circulating fake information and to increase the sense of community. Second, a telephone helpline should be considered for outpatients and families. Then, patients and staff should be regularly screened for any sign of depression and/or suicide intentions. Rotation of staff working in COVID-19 services should also be considered. Finally, we should support the use of tele-consulting for psychological evaluation and help as well as for communication between patients and their families.

For other problems, patients with severe and critical COVID-19 frequently show hypercoagulability (as demonstrated by elevated d-dimer level), which can in some cases evolve to disseminated intravascular coagulation along with prolonged immobility. Prolonged anticoagulation with low-molecular-weight heparin is strongly recommended [12].

The rapid spread of the COVID-19 pandemic will probably modify the organisation and functioning of PMR services. Many countries have reduced rehabilitation treatments for outpatients with chronic conditions in response to social distancing policies implemented to reduce the spread of the infection in the population. To deal with the COVID-19 pandemic consequences, an ideal organisational treatment template simply does not exist. Each setting and country has its peculiarities, and any recommendation need to be adapted individually. However, the experience from the field shows that some suggestions must be considered and should be shared among the PMR community.

The first consideration is that patients with severe and critical COVID-19 are potentially very unstable and have very low exercise tolerance, even in the younger population. Therefore, the role of physical therapy in acute-care units and ICUs is limited. The transfer to a rehabilitation setting should be performed only if the referring clinician in the acute-care unit is reasonably sure that the patient's condition will not worsen and the patient will not need to return back to the ICU or acute-care setting. From clinical experience, our recommendations for transferring patients to rehabilitation are to avoid direct transfer from the ICU. Patients with severe forms in acute care should be transferred to PMR only if they have stable $SatO_2$ and RR and radiological progression of the disease has been ruled out. When the patient is stabilised for at least 3 days (no recurrence of fever; both RR and $SatO_2$ stable), they can be transferred to PMR settings (Fig. 1). All staff working in the COVID-19–positive unit should be screened before and after each shift for symptoms and fever. Some procedures, such dysphagia treatment, should be considered at high risk of contamination (the same for aerosol-producing procedures), and clinicians should be aware that every patient should be considered potentially infective until proven otherwise.

We strongly advise implementing tele-consultation and tele-rehabilitation devices, minimising exposure risk and implementing communication technologies to help patients and families reduce barriers imposed by isolation.

We suggest the following criteria for admission to PMR (Table 1):

- $\geq$ 7 days from diagnosis of COVID-19;
- at least 72 hrs with no fever and no fever-reducing medication;
- stable RR and $SatO_2$;
- clinical and/or radiological evidence of stability (CT-scan or lung ultrasonography).

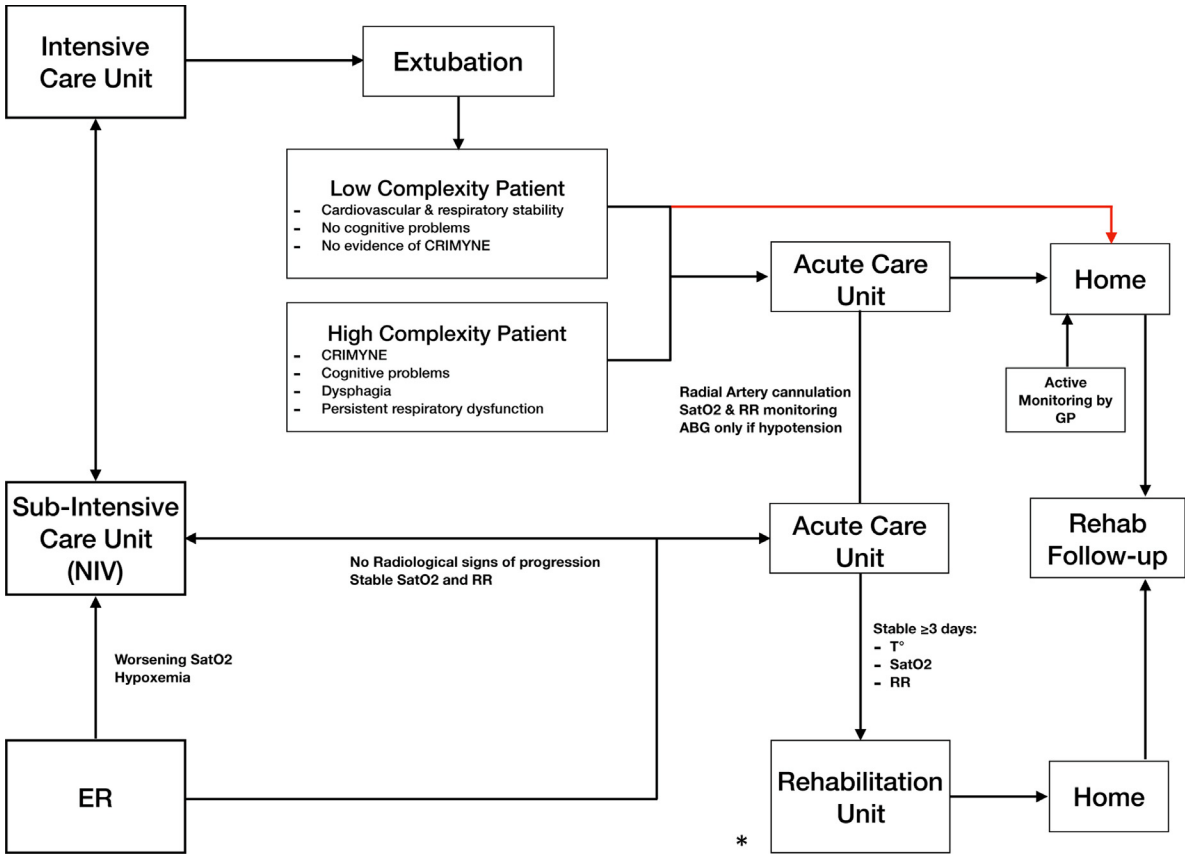

Fig. 1. Flow of COVID-19 patients to rehabilitation. ER: emergency room; NIV: non-invasive ventilation; $SatO_2$: arterial oxygen saturation; RR: respiratory rate; ABG: arterial blood gas; GP: general practitioner; Red line: in case of congestion of acute care unit services.

Table 1
Suggested admission criteria for physical medicine and rehabilitation (PMR) for COVID-19 patients.

≥ 7 days from diagnosis of COVID-19
At least 72 hrs with no fever and no fever-reducing medication
Stable RR and $SatO_2$
Clinical and/or radiological evidence of stability (CT-scan or lung ultrasonography)

Clinical messages (lessons learned from experience)
The clinical condition of COVID-19 patients can rapidly evolve in the first 7–10 days. The risk of deterioration should be carefully evaluated before early transfer of such patients to PMR services
If possible, COVID-19–positive and–negative PMR services should be physically separated and have different staff
Dysphagia evaluation and rehabilitation should be considered potentially an aerosol-producing maneuvre. Therefore, all patients with dysphagia (from stroke or other reason), unless the contrary is proven, should be considered to have COVID-19 (with the need to use appropriate personal protective equipment according to the country or institution guidelines)
Preferably admit COVID-19–negative patients with non-invasive ventilation to single rooms only. If they become infected during the rehabilitation, the risk of staff and roommate infection is very high
Careful consideration should be given to problems related to in-hospital isolation of patients with severe cognitive and communication deficits
Carefully consider the impact of psychiatric consequences of COVID-19 patients (severe and critical forms), their families and the staff. Consider also the impact on patients with chronic disability (primarily cognitive disability) living at home or in an institution
Consider access to rehabilitative care for patients with chronic and acute disabilities during the COVID-19 pandemic

RR: respiratory rate; $SatO_2$: blood oxygen saturation.

During rehabilitation, RR and $SatO_2$ in COVID-19 patients should be monitored on a regular basis, to quickly identify clinical degradation.

Disclosure of interest

The authors declare that they have no competing interest.

References

[1] The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. The epidemiological characteristics of an outbreak of 2019 novel Coronavirus Diseases (COVID-19) [Internet]; 2020 [cited 2020 Mar 26; available from: http://weekly.chinacdc.cn/en/article/id/e53946e2-c6c4-41e9-9a9b-fea8db1a8f51].

[2] Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet 2020;395:1054–62.

[3] Hui DS, Wong KT, Ko FW, Tam LS, Chan DP, Woo J, et al. The 1-year impact of severe acute respiratory syndrome on pulmonary function, exercise capacity, and quality of life in a cohort of survivors. Chest 2005;128:2247–61.

[4] Kenn K, Gloeckl R, Behr J. Pulmonary rehabilitation in patients with idiopathic pulmonary fibrosis – a review. Respiration 2013;86:89–99.

[5] Mao L, Wang M, Chen SY, He Q, Chang J, Hong C, et al. Neurological manifestations of hospitalised patients with COVID-19 in Wuhan, China: a retrospective case series study. medRxiv 2020 [02.22.20026500].

[6] Filatov A, Sharma P, Hindi F, Espinosa PS. Neurological complications of Coronavirus Disease (COVID-19): encephalopathy. Cureus 2020 [cited 2020 Apr 1; available from: https://www.cureus.com/articles/29414-neurological-complications-of-coronavirus-disease-covid-19-encephalopathy].

[7] Li Y-C, Bai W-Z, Hashikawa T. The neuroinvasive potential of SARS-CoV2 may play a role in the respiratory failure of COVID-19 patients. J Med Virol 2020. http://dx.doi.org/10.1002/jmv.25728.

[8] Moriguchi T, Harii N, Goto J, Harada D, Sugawara H, Takamino J, et al. A first case of meningitis/encephalitis associated with SARS-Coronavirus-2. Int J Infect Dis 2020. http://dx.doi.org/10.1016/j.ijid.2020.03.062.

[9] Hopkins RO, Weaver LK, Collingridge D, Parkinson RB, Chan KJ, Orme JF. Two-year cognitive, emotional, and quality-of-life outcomes in acute respiratory distress syndrome. Am J Respir Crit Care Med 2005;171:340–7.

[10] Ong K-C, Ng AW-K, Lee LS-U, Kaw G, Kwek S-K, Leow MK-S, et al. Pulmonary function and exercise capacity in survivors of severe acute respiratory syndrome. Eur Respir J 2004;24:436–42.

[11] Brodsky MB, Huang M, Shanholtz C, Mendez-Tellez PA, Palmer JB, Colantuoni E, et al. Recovery from dysphagia symptoms after oral endotracheal intubation in acute respiratory distress syndrome survivors. A 5-year longitudinal study. Ann Am Thorac Soc 2017;14:376–83.

[12] Li T, Lu H, Zhang W. Clinical observation and management of COVID-19 patients. Emerg Microbes Infect 2020;9:687–90.

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