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## Rehabilitation following critical illness in people with COVID-19 infection

Dr Robert Simpson, PhD MBChB\*

University of Toronto

Sunnybrook Health Sciences Centre

Larry Robinson, MD

University of Toronto

Sunnybrook Health Sciences Centre

\*Corresponding author: [robert.simpson@sunnybrook.ca](mailto:robert.simpson@sunnybrook.ca)

Sunnybrook Health Sciences Centre H390

2075 Bayview Ave

Toronto, ON

Canada M4N 3M5

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## **Abstract**

The current COVID-19 pandemic will place enormous pressure on healthcare systems around the world. Large numbers of people are predicted to become critically ill with acute respiratory distress syndrome (ARDS) and will require management in intensive care units (ICUs). High levels of physical, cognitive and psychosocial impairments can be anticipated. Rehabilitation providers will serve as an important link in the continuum of care, helping move patients on from acute sites to eventual discharge to the community. Likely impairment patterns, considerations for healthcare practitioner resilience, and organization of services to meet demand are discussed. Innovative approaches to care, such as virtual rehabilitation, are likely to become common in this environment.

### **Key Words:**

COVID-19, coronavirus, acute respiratory distress syndrome, pandemic

## **Introduction**

On March 11<sup>th</sup> 2020 the World Health Organization (WHO) declared a pandemic in relation to infection with Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV2), a novel coronavirus, hereafter referred to as COVID-19<sup>1</sup>. For the majority (81%)<sup>2</sup> infection with COVID-19 will confer a mild disease; fever (88.7%), cough (57.6%), and dyspnea (45.6%) being the most commonly reported symptoms in a recent systematic review and meta-analysis<sup>3</sup>. However, for a significant minority, and particularly those aged >65 years and with co-morbidities such as hypertension and diabetes, the infection may have very serious consequences<sup>4</sup>. In those patients requiring hospitalization, a relatively high proportion (20.3%) have required management in an intensive care unit (ICU) environment, the most common reason being the development of acute respiratory distress syndrome (ARDS) (32.8%)<sup>3</sup>. Less commonly, patients may develop acute liver injury, acute cardiac injury, acute kidney injury, and viraemic septic shock<sup>1</sup>. In a meta-analysis, among hospitalized patients with COVID-19 infection, a case fatality rate of 13.9% has been reported<sup>3</sup>. The leading cause of death following COVID-19 infection is acute respiratory failure, and disseminated intravascular coagulopathy has been reported in 71% of non-survivors<sup>1</sup>.

Currently, there are no known effective treatments for COVID-19 infection specifically; general measures recommended are supportive<sup>1</sup>. Given that COVID-19 is a novel coronavirus, where etiopathology remains incompletely understood<sup>1</sup>, it is important to note that current approaches to care described in this manuscript are based on treatments extrapolated from diverse underlying health conditions. However, this is a rapidly evolving literature. The WHO is coordinating the five-treatment arm 'Solidarity' trial, testing remdesivir, lopinavir/ritonavir, lopinavir/ritonavir plus interferon beta, and chloroquine. For the critically ill with COVID-19 associated ARDS, supportive management at present means<sup>5</sup>:

- Conservative intravenous (IV) fluids
- Empirical IV antibiotics for suspected bacterial coinfection
- Consideration for early, invasive endotracheal intubation and ventilation to maintain adequate oxygenation and carbon dioxide elimination
- Lung protective ventilation strategies, such as limiting tidal volumes and inspiratory pressures
- Periods of prone positioning whilst mechanically ventilated to decrease the risk of mechanical lung injury
- Consideration of extracorporeal membrane oxygenation

As the spread of COVID-19 continues to accelerate despite extraordinary public health measures to prevent transmission, and given the high proportion of hospitalized patients requiring ICU level care, it is likely that in the weeks and months following the surge in patients being admitted to acute hospitals and critical care units there will be considerable number of critical illness survivors requiring rehabilitation<sup>6</sup>. Indeed, the WHO Emergency Medical Team minimum standards recommend that rehabilitation is a core component of patient-centred care in responding to disasters, with minimum standards recommended with regards to staffing, equipment and space<sup>7</sup>. It is thus important that rehabilitation providers develop plans to receive large numbers of patients from acute care facilities, possibly directly from the ICU<sup>8</sup>. Rehabilitation professionals and facilities will play an important role in helping speed the recovery of those survivors with residual impairments post-ICU, but also a critical role in providing an appropriate outlet for acute services, creating space for newly affected patients to receive the acute care they need<sup>9</sup>. Rehabilitation should be routinely incorporated into pandemic response plans early on, rather than in retrospect, only after widespread disability becomes apparent<sup>10</sup>.

### **COVID-19 infection, ARDS and disability**

Critical illness for any reason has major long term sequelae, prompting the characterization of 'post-ICU syndrome', defined as 'new or worsening impairment in physical, cognitive, or mental health status arising after critical illness and persisting beyond discharge from the acute care setting'<sup>11</sup>. Following ARDS, patients can present with numerous functional impairments across bio-psycho-social domains<sup>12</sup>.

### **Physical function**

In a cohort study of 109 survivors, lung volume and spirometry were normal six months following ARDS, however carbon monoxide diffusion capacity was persistently impaired, with a median value of 63-72% predicted value<sup>13</sup>. At 5 years, spirometry was reported as 'normal to near normal', with computed tomography (CT) demonstrating 'minor, non-dependent fibrotic changes consistent with ventilator induced lung injury'<sup>14</sup>. ICU-acquired weakness (ICUAW) is very common following ARDS, estimates suggesting anywhere between 25-100%<sup>15</sup>; thought to relate to immobility, suboptimal glycemic control and iatrogenic use of steroids and neuromuscular blocking agents<sup>12</sup>. Critical illness polyneuropathy and critical illness myopathy are also common, reported in almost 25-46% and 48-96% respectively<sup>16</sup>. ICUAW confers a major determinant of poor long term functional outcome and costly rehabilitation and care needs<sup>12</sup>. Other, less common physical sequelae of prolonged immobility may also occur, including cardiorespiratory deconditioning, postural instability, venous thromboembolism, muscle shortening, contractures (myogenic, neurogenic, arthrogenic), and pressure injuries. Some of these secondary complications can be anticipated in critically ill and immobilized patients and are to some extent preventable.

### **Cognitive function**

Impairment of cognitive function is common following ARDS<sup>17</sup>. Delirium can affect up to 80% in general ICU settings<sup>18</sup>. Delirium commonly occurs in acute illness and hospitalization, is more common in those with sepsis, the elderly and multimorbid, is associated with worse functional outcomes and a higher mortality rate<sup>18</sup>. Cognitive impairment following ARDS has been noted to affect the majority of survivors at hospital discharge and in around 10% impairments are persistent at long term follow up<sup>17</sup>.

Neuropsychological impairments are multidimensional, and include memory, attention and higher order executive functions<sup>17</sup>. Treatment of ICU acquired delirium is challenging and largely preventative<sup>19</sup>. The Society of Critical Care Medicine recommend the ABCDEF bundle: Assess, prevent and manage pain; Both spontaneous awakening and breathing trials; Choice of sedation; Delirium monitoring and management; Early mobility and exercise; Family engagement and empowerment<sup>20</sup>.

### **Psychosocial wellbeing**

Persistent mental health impairment is commonly described following treatment in the ICU<sup>21</sup>, with pooled estimates reporting high prevalence rates of depression (29%)<sup>22</sup>, PTSD (22%)<sup>23</sup> and anxiety (34%)<sup>24</sup> affecting survivors at 1 year. Beyond this, pandemics are associated with high levels of emotional distress across society<sup>25</sup>. On the individual level, dyspnea is generally recognized as a distressing experience in its own right<sup>26</sup>. For patients and families, admission to hospital with a COVID-19 diagnosis may raise fears for survival<sup>27</sup>. To compound matters, due to infection control requirements and public health imperatives, patients may be separated from families for prolonged periods, particularly if critically ill. It seems likely that having the infection will carry a social stigma<sup>28</sup>, including among healthcare providers<sup>29</sup> who will necessarily seek to limit case contact to bare essentials, further limiting social interaction for patients. ICU admission with critical illness affects patient's families profoundly<sup>30</sup>, where impairment of mental health is also common<sup>31</sup>. In the context of a pandemic, it is



possible that families may not see or speak to their loved one at all during admission; in fatal cases never again.

### **Acute Care Rehabilitation:**

Rehabilitation following critical illness is a key component in the continuum of care. Rehabilitation is a complex intervention<sup>32</sup> and refers to a longitudinal process focused on minimizing the disabling effect of an individual's impairments, promoting and optimizing functional independence in activities of daily living, and maximizing opportunities to participate meaningfully in society on the basis of any new functional baseline<sup>32</sup>. Rehabilitation is best delivered by specialists in multidisciplinary teams (MDT) with a broad range of skills to support bio-psycho-social functioning<sup>33-35</sup>. Existing evidence for effectiveness suggests that MDT rehabilitation should start early in the course of hospital treatment<sup>36</sup>, involve patients and family in goal planning as far as possible/practical<sup>37</sup>, and consider holistic bio-psycho-social needs, taking into consideration likely short-, medium-, and longer- terms care trajectories<sup>38</sup>. MDT meetings and interactions with patients, families and between professionals will likely be limited during the COVID-19 pandemic. Maintaining active, reciprocal lines communication between a finite number of care providers will be important for effective co-ordination of care, avoidance of redundancy/unnecessary duplication of services. The same holds true when communicating with patients and families.

Rehabilitation in the ICU may involve screening for delirium and use of general prevention strategies, medication review, planned regular sedation breaks, multimodal attempts at orientation, passive and active mobilization, and, where possible, begin to build an empathic, compassionate therapeutic alliance with the patient and family. Active mobilization in the ICU has been manualized. For example, Green et al. (2016) suggest that if a patient does not have independent sitting balance and a Medical Research

Council (MRC) power score of <3 in the lower limbs, 'phase 1' mobilization should start with sitting balance practice, use of a tilt table and muscle strengthening exercises. Those with independent sitting balance and an MRC power score  $\geq 3$  can progress to 'phase 2' mobilization with supported/active weight bearing with exercises including 'sit-to-stand', marching on the spot +/- gait aid, eventually moving away from the bed space +/- a gait aid<sup>39</sup>. Early active mobilization is associated with improved muscle strength, better mobility status at hospital discharge, and more days alive out of hospital<sup>40</sup>. A commonly described barrier to active mobilization in the ICU is fear that this may interfere with critical life support devices, such as endotracheal tubes, chest drains, arterial and central venous access lines, and dialysis catheters<sup>41</sup>. However, various studies have confirmed that active mobilization is feasible and safe in these circumstances and consensus recommendations, such as the 'traffic light' system<sup>42</sup>, can be used to guide the ICU/rehabilitation team in this regard. Rehabilitation providers working in the ICU must know how to identify confirmed cases of COVID-19, as well as those actively under investigation. Rehabilitation providers may have to don personal protective equipment (PPE), a practice with which they may have limited experience<sup>43</sup>, and it is important that they are aware of correct donning and doffing guidelines<sup>44</sup>, besides general conservation strategies. Extra planning may be necessary when coordinating patient assessments, so as to avoid having to throw away masks and vizors between patients.

Step down from an ICU environment to ward level care will likely come with mixed feelings for patients and families. In one sense this juncture may represent a turning point in care and recovery, where the greatest risk is perceived as having passed<sup>45</sup>. On the other hand, the patient may still be considered infective, requiring ongoing isolation, and disease reactivation has been observed in COVID-19 patients discharged from hospital<sup>1</sup>. Patients are also likely to be considerably impaired after prolonged sedation, immobilization, mechanical ventilation, and delirium<sup>12</sup>. The patient may remain highly dependent for personal care and activities of daily living fulfilment<sup>46</sup>, and is likely to be emotionally distressed<sup>21</sup>. Acute

disablement is distressing for patients and families and in qualitative synthesis is described as a disorienting experience<sup>47</sup>. It is therefore important to provide simple, honest, accurate, factual information regarding treatments thus far, likely next steps, and to make time to explore ideas, concerns and expectations that patients and families may have. Baseline measures of function taken in the ICU can be compared with current status and the patient may at this stage have a greater capacity for involvement with goal planning and engagement with therapy sessions. Emphasis on enabling self-care may become increasingly important if staff resources are depleted, thus provision of information to patients and families regarding how to carry on therapeutic interventions beyond treatment sessions should feature strongly in the formulations and interventions provided.

### **Inpatient Rehabilitation**

Many of the patients who survive COVID-19 associated critical illness will require admission to an inpatient rehabilitation facility in order to optimize functional status prior to eventual discharge and community re-integration. In the context of a pandemic, special considerations are required with regards to when a patient is 'ready' for transfer to such a facility<sup>8</sup>. Ideally, patients being transferred from acute facility to rehabilitation setting should have no ongoing signs or symptoms of COVID-19 infection including resolution of fever without antipyretics, documented evidence of two consecutive negative virologic specimens (i.e. nasopharyngeal throat swabs) 24 hours apart<sup>48</sup>, and a clear written plan with regards to code status<sup>8</sup>. Inpatient rehabilitation populations typically comprise a particularly vulnerable patient group. They are likely to be older, may be immunosuppressed, multimorbid, and dependent on others for fulfillment of basic personal activities of daily living, meaning they require regular daily physical contact with health care providers trained to assist with personal care and safe mobilization<sup>8</sup>. Isolation in such a setting is challenging.

Ultimately, however, it is possible that in some localities patients with active COVID-19 and associated disability will need admission to inpatient rehabilitation facilities, particularly if acute care hospitals become full during the pandemic. This will be challenging for several reasons. First, PPE for staff in general may not be available as worldwide shortages have been well described and what supplies do exist are likely to be prioritized for acute care sites, where aerosolizing procedures (i.e. intubation, cardiopulmonary resuscitation - CPR) carry the highest risk<sup>49</sup>. In addition, access to resuscitative equipment and expertise will also be less readily available than in the acute hospital, and transfer back to an acute facility may not be possible in the context of mass, population-level infection and illness. For staff safety, wherever possible, appropriate PPE must be in place in the event of a patient requiring CPR.

Whether patients with active infections come or not, inpatient rehabilitation units will still have to plan for a surge in patient admissions, on top of established work streams, including those requiring inpatient rehabilitation following stroke, trauma and exacerbations of pre-existing conditions such as multiple sclerosis. Bed availability is likely to be constrained and difficult decisions will be required with regards to prioritizing which patients need inpatient rehabilitation and could not otherwise be managed in another, less specialist facility, or at home. Rehabilitation units will have to consider how to minimize risk of spread of COVID-19 among inpatients, which may mean designating a specific area for such individuals<sup>8</sup>, a healthy workplace policy screening and preventing staff with symptoms from working<sup>8</sup>, guided by infection control/occupational health policies and procedures. Care episodes may have to preferentially take place at the bedside and in a more rudimentary fashion than is custom.

Congregations in gyms and common spaces are likely to be off limits<sup>8</sup>. Minimum criteria for safe discharge to a less specialist facility or home may need to be fast tracked and implemented at scale<sup>8</sup>. This will require multi-stakeholder engagement, training and co-operation, potentially via virtual media and will likely challenge habitual working patterns and levels comfort with decision making.

Rehabilitation physicians in several developed healthcare systems rely on billing schedules for reimbursement. This is a time consuming endeavor, feeds in to physician burnout<sup>50</sup>, and in the context of the COVID-19 pandemic may detract from precious patient care episodes. Pro-active administrative support mechanisms may largely offset this challenge, whereby a centralized, coordinated approach can be used by all specialists working in rehabilitation in a given area to cut down on physician administrative time, freeing up clinical capacity. Flexible working hours may be required for some staff, as schools close and childcare needs emerge<sup>29</sup>. Equally important is healthcare provider wellness in the context of an extraordinarily stressful social and work environment. In the USA, rehabilitation physicians are already among the most ‘burned out’<sup>50 51</sup>. Wellness resources with existing evidence for effectiveness, such as virtual mindfulness-based interventions<sup>52</sup> and/or Schwartz rounds<sup>53</sup> could be made available to support staff wellbeing, providing both self-care skills and an important source of social support.

Because the disabling effects resulting from ARDS are typically both complex and long lasting<sup>12</sup>, it is expected that outpatient multidisciplinary rehabilitation follow-up will need to continue for an extended period after discharge from inpatient rehabilitation. A variety of ‘post-ICU clinic’ models have been described, but the optimal model remains unclear; given the range and complexity of impairments described, pooling expertise from multiple disciplines (intensivist, clinical psychologist, physiatrist and others) depending on patient need is often required<sup>54 55</sup>. However, it is also important to remember that many patients with existing disabling conditions will have been waiting to see a rehabilitation specialist prior to the outbreak of COVID-19; it is likely that their appointments will have been postponed, if not cancelled outright.

### **Innovative approaches to providing rehabilitation during the COVID-19 pandemic**

## **Virtual rehabilitation**

In the context of the COVID-19 pandemic, virtual care outpatient episodes may be preferable to face-to-face interactions for multiple reasons. Firstly, in order to take care of patients, healthcare providers must first themselves be in good health<sup>56</sup>. The healthcare population, physicians in particular, is aging<sup>57</sup>. In the USA >20% of physicians are over 65 yrs<sup>57</sup>. Many older healthcare practitioners will have their own long-term health conditions and may fear for their safety on exposure to COVID-19 patients. Secondly, from a patient, family and wider societal perspective, delivering healthcare in settings where groups of people gather such as 'waiting rooms' is actively discouraged for fear of further community spread<sup>1</sup>. In this context, it is also possible that a healthcare provider may be carrying COVID-19 asymptotically; in such a case the healthcare provider may then inadvertently become a 'super spreader'<sup>1</sup>. Virtual care circumvents these issues and allows personalized consultation and treatment via telephone or live internet connections, or via pre-recorded sessions for more generic materials<sup>58</sup>. In some countries, well developed, secure virtual care platforms already exist; in others, media such as Zoom, Skype, Facetime and others may be suitable alternatives. However, virtual care also has many limitations, such as ready availability of equipment, technical malfunctions, potential for inadvertent personal data disclosure, limited scope for physical examination, and the process largely relies upon the patient being able to attend to sessions, communicate and interact accordingly<sup>59</sup>. This may not be possible for many patients. Rehabilitation providers should start to consider the scope and limitations of virtual physical examinations and make patients expressly aware of this accordingly.

## **Prehabilitation**

A related construct to rehabilitation is pre-habilitation. Pre-habilitation operates on the premise that those who take pre-emptive steps to optimize their general health and fitness have better outcomes

following the stress challenge of elective surgery<sup>60</sup>. A recent opinion article<sup>61</sup> in the British Medical Journal makes the case for pre-habilitation in the context of the COVID-19 pandemic. In brief, the following pre-habilitative interventions are recommended: smoking cessation, regular exercise, good nutrition, and stress reduction<sup>61</sup>. Although there is no direct evidence to support pre-habilitation in the context of COVID-19, it seems likely that good general health measures such as those suggested will confer benefit to people generally, particularly those with pre-existing long term conditions<sup>62</sup>. In this view, rehabilitation specialists could have an important public health role to play in educating patients and families through provision of evidence based, personalized recommendations for home-based physical activity<sup>62</sup>, nutrition<sup>63</sup>, managing stress<sup>64</sup> and stopping smoking<sup>65</sup>. Finally, rehabilitation specialists, like all health professionals, through their extensive contact with patients, also have an opportunity to reinforce the importance of current public health measures designed to stop the spread of COVID-19, namely effective handwashing, respiratory hygiene, and social distancing<sup>1</sup>.

### **Summary**

COVID-19 associated critical illness will have dramatic implications for patients, families and healthcare workers around the world. Healthcare services will have to adapt rapidly to an anticipated surge of cases and this will place enormous strain on acute services. Rehabilitation professionals will have a critical role in assisting people recover from COVID-19 associated critical illness, make sense of their experiences, help optimize independent function, and facilitate community re-integration. While COVID-19 is a novel disease, rehabilitation providers already routinely treat patients who suffer disability as a result of critical illness generally, and ARDS specifically. However, we need to take care of each other in the crisis we face and being prepared is a major first step in this regard.

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