

ORIGINAL REPORT

CHARACTERISTICS AND OUTCOMES OF COVID-19-POSITIVE INDIVIDUALS
ADMITTED FOR INPATIENT REHABILITATION IN TORONTO, CANADA

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Objective: To describe the sociodemographic features, impairments, and functional changes of COVID-19-positive individuals who underwent inpatient rehabilitation at three rehabilitation hospitals in Toronto, Canada.

Design: Retrospective chart review of patients admitted to three COVID-19 rehabilitation units between 20 April 2020 and 3 June 2020. Sociodemographic factors, impairments, length of stay, and Functional Independence Measure data were reported.

Results: A total of 41 patients were included in this study, including 22 males and 19 females. The median age was 75 years. Thirty-six percent of patients were admitted to the intensive care unit during their acute stay. The most commonly affected body functions were: neuromusculoskeletal (73.2%); combined cardiovascular, haematological, immunological, and respiratory (65.9%); and mental functions (29.3%). Median total Functional Independence Measure score was 85 at admission and 108.5 at discharge.

Conclusion: This study represents some of the first data on the characteristics and outcomes of COVID-19-positive individuals admitted to inpatient rehabilitation in Toronto, Canada early in the COVID-19 pandemic.

Key words: COVID-19; inpatient rehabilitation; pandemic; physiatry; impairment.

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LAY ABSTRACT

Individuals hospitalized with COVID-19 may experience a decline in mobility and independence with self-care, requiring inpatient rehabilitation prior to discharge home. In Toronto, Canada, 3 inpatient rehabilitation hospitals developed units to provide treatment to COVID-19-positive individuals. The clinical and sociodemographic features of patients admitted for rehabilitation between 20 April 2020 and 3 June 2020 were studied. Forty-one patients (22 males, 19 females), median age 75 years, were included. Thirty-six percent of patients were admitted to the intensive care unit during their acute care stay. The most commonly affected body functions were: nerves, muscles, and bones (73.2%); combined cardiovascular, blood, immune, and lungs (65.9%); and mental functions (29.3%). Median Functional Independence Measure score was 85 at admission and 108.5 at discharge. This study represents some of the first data on characteristics and outcomes of COVID-19-positive individuals admitted to inpatient rehabilitation in Toronto, Canada early in the COVID-19 pandemic.

On 11 March 2020, the World Health Organization (WHO) declared a pandemic as a result of COVID-19 (1). By late spring 2020, thousands of individuals in Toronto had been diagnosed with COVID-19, of whom approximately 15% required hospitalization (2). Critical illness, including that related to COVID-19, is associated with physical, cognitive, and psychosocial sequelae, including anxiety, depression, and post-traumatic stress disorder (PTSD) (3–5). Many individuals admitted to hospital will require rehabilitation to address the resulting functional impairments from hospitalization with COVID-19 infection.

In April 2020, 3 inpatient rehabilitation facilities in Toronto opened units dedicated to the provision of rehabilitative services for individuals who were COVID-19-positive. Persons treated on these units included those with either a primary or secondary diagnosis of COVID-19. Individuals with primarily respiratory symptoms who developed complications from COVID-19, such as deconditioning or post-intensive care unit (post-ICU) syndrome (4), were considered to have a primary diagnosis of COVID-19, whereas an individual who sustained a hip fracture from a fall, but incidentally tested positive for COVID-19, was considered to have a secondary diagnosis.

Preliminary research recognizes the role of rehabilitation for patients who have survived critical illness after COVID-19 infection (5, 6). There has been relatively less work exploring the characteristics of these rehabilitation inpatients, particularly those with milder disease. Circi et al. (7) characterized pulmonary function and disability in a cohort of patients admitted to a COVID-19 rehabilitation unit; however, all of the patients included in their study had been previously admitted to the ICU and required respiratory support, which is reflective of a more severe disease course.

From a systems perspective, the hospital administrators, as well as the regional healthcare system leadership, saw value in COVID-19 recovery units in Toronto, specifically for patients who remained COVID-19-positive at the time of admission. Therefore, understanding the impairments, rehabilitation needs, and outcomes of individuals being treated on COVID-19 recovery units may assist with optimization of rehabilitation programmes, as well as serve as pilot data for future studies.

The main objective of this study was to describe the sociodemographic features, impairments, and functional changes in COVID-19-positive individuals who received inpatient rehabilitation at three rehabilitation hospitals in Toronto, Canada.

METHODS

Ethics approval

This project was approved by the Research Ethics Boards (REB) of Sinai Health, Sunnybrook Health Sciences Centre, and Unity Health Toronto. Informed consent was obtained from participants from Sinai Health with REB approval for both verbal or written consent, whereas the requirement for informed consent was waived by the other 2 institutional REBs.

Study design and participants

This was a retrospective chart review of individuals admitted to COVID-19 recovery units at 1 of 3 rehabilitation hospitals in Toronto, Canada. Toronto has a population of 2.8 million, with the Greater Toronto Area totalling 6 million.

Inclusion criteria were: individuals ≥ 18 years of age, documented COVID-19-positive diagnosis, and admitted to a designated COVID-19 inpatient recovery unit. One of the aims of this project was to collect preliminary data to aid in the development of potential future studies. As a result, patients admitted to in-

patient rehabilitation for longer than 12 weeks were excluded, in order to allow for timely completion of the current analysis. Persons admitted for palliative care were also excluded.

COVID-19 recovery units

During the first wave of the COVID-19 pandemic, there was a coordinated regional effort to meet the needs of individuals impacted by COVID-19 and to support patient flow in acute care facilities. Three rehabilitation hospitals opened dedicated COVID-19 recovery units in Toronto, Canada: Bridgepoint Active Healthcare – Sinai Health; Providence Healthcare – Unity Health Toronto; and St John's Rehabilitation – Sunnybrook Health Sciences Centre.

Each of the hospitals aligned well with their approach and admission criteria, which included a positive COVID-19 PCR swab, age over 18 years, medically stable, and a need for inpatient rehabilitation. At Providence Healthcare, only those patients who had not yet had a negative COVID-19 swab were admitted to the isolation unit. Therefore, data on patients who had an extended acute care stay and tested negative for COVID-19 prior to transfer to rehabilitation would not have been captured from this institution.

The COVID-19 recovery units varied in size. Providence Healthcare had a 10-bed unit, whereas Bridgepoint Active Healthcare had a 32-bed unit. St John's Rehabilitation dedicated a portion of a 38-bed unit to COVID-19 rehabilitation; however, due to isolation requirements and the inability to use all beds in 4-person or 2-person rooms, up to 7 patients were admitted at a time.

The primary rehabilitative care goals were to assess and treat functional limitations from physical and cognitive impairments as well as psychosocial anxiety, depression, PTSD) sequelae related to a COVID-19 diagnosis, and to support discharge home. Rehabilitative care teams consisted of a hospitalist, physiatrist, nursing, physiotherapist, occupational therapist, speech language pathologist, social worker, recreation therapist, dietitian, pharmacist, ward aides, and environmental services. Specialists available by consultation included geriatrics and consult liaison psychiatry, with internal medicine available at Bridgepoint Active Healthcare and via telephone at Providence Healthcare.

Rehabilitation was delivered in patients' rooms while on precautions, utilizing functional and body weight exercises and other devices, as appropriate. Staff provided care while wearing a gown, gloves, appropriate medical mask, and face shield (droplet precautions) until 2 nasopharyngeal PCR swabs were negative 24 h apart. Given advances in the understanding of the infectious phase of COVID-19, recommendations were altered throughout the duration of this study. At both Bridgepoint and St John's, isolation precautions were later removed when individuals were 14 days from symptom onset or from first COVID-19-positive result (if asymptomatic or improving). At Providence Healthcare, patients were transferred off the COVID-19 recovery unit to continue their rehabilitation once they had 2 negative PCR tests 24 h apart. At Bridgepoint, patients remained on the same unit, but were provided therapy outside their room, including in communal gyms once isolation precautions were removed. Care conferences were provided if complex discharge planning was required.

Variables

Baseline sociodemographic features and clinical characteristics included age, sex, marital and employment status, pre-admission living setting and arrangement, baseline functional status, and co-morbidities. Acute care data included length of stay (LOS; discharge-admission date) and whether the individual required

ICU admission, extracorporeal membrane oxygenation, or a ventilator. Neurological complications previously described to be associated with respiratory viruses were recorded (8).

Rehabilitation data included the health condition that best reflected the reason for rehabilitation admission, based on the Canadian Institute for Health Information (CIHI) Rehabilitation Client Groups (9) and the affected body functions, according to the WHO (10). Other rehabilitation data included LOS (discharge – admission date), admission and discharge total, motor and cognitive FIM scores (11); admission Montreal Cognitive Assessment (MoCA) score (as available); the number of readmissions to acute care; as well as discharge setting and arrangement. In instances where the MoCA blind was performed, the result was converted to a score out of 30 (12).

Data sources

Data were obtained from review of the patient paper and/or electronic medical record. This included review of the inpatient rehabilitation application, acute care discharge summary and accompanying notes, as well as medical and allied health inpatient rehabilitation notes.

Statistical analysis

Data from the 3 sites were aggregated. Using Microsoft Excel, medians and interquartile ranges were calculated for continuous variables and proportions and frequencies for categorical variables.

RESULTS

The data of 41 individuals admitted to acute care between 2 March 2020 and 27 May 2020 and subsequently admitted to inpatient rehabilitation between 20 April 2020 and 3 June 2020 were recorded. The median time from documented COVID-19 diagnosis to inpatient rehabilitation admission was 19 days (interquartile range (IQR) 12–32 days).

Baseline clinical and sociodemographic features are summarized in **Table I**. The majority of patients were independent at baseline (prior to COVID-19 infection). Four individuals (9.8%) required assistance with bathing, grooming, dressing, and toileting at baseline. For the 11 individuals who required ventilation, the median number

Table I. Baseline clinical and sociodemographic features $n = 41$

Characteristics	Total
Age, median (IQR)	75 (58–84)
Male sex, n (%)	22 (53.7)
Single, n (%)	24 (58.5)
Employed, n (%)	11 (26.8)
Admitted from home, n (%)	37 (90.2)
Living alone, n (%)	14 (34.1)
Stairs at home, n (%)	17 (41.5)
Co-morbidity, n (%)	
Hypertension	30 (73.2)
Diabetes	15 (36.6)
Central nervous system impairment	15 (36.6)
Acute care LOS, median (IQR)	19 (12–31)
ICU stay, n (%)	15 (36.6)
Ventilator, n (%)	11 (26.8)

IQR: interquartile range; LOS: length of stay; ICU: intensive care unit.

Table II. Affected body functions, $n = 41$

Body functions	Total
Neuromusculoskeletal, n (%)	30 (73.2)
Cardiovascular, haematological, immunological, respiratory, n (%)	27 (65.9)
Mental functions, n (%)	12 (29.3)
Genitourinary and reproductive, n (%)	7 (17.1)
Sensory and pain, n (%)	4 (9.8)
Digestive, metabolic, endocrine, n (%)	4 (9.8)
Skin and related structures, n (%)	3 (7.3)
Voice and speech, n (%)	0 (0.0)

of ventilation days was 18 (IQR 12.5–19 days). Five individuals (12.2%) had 1 or more of the following neurological complications: critical illness neuromyopathy, encephalitis/encephalopathy, and/or seizures.

The most commonly affected body functions were: neuromusculoskeletal (73.2%), cardiovascular, haematological, immunological, and respiratory (65.9%), and mental functions (29.3%) (**Table II**).

The most frequent admission Rehabilitation Client Group was “Medically Complex” ($n = 29$, 70.7%). The median rehabilitation LOS was 16 days (IQR 13–22), with an admission total FIM of 85 (IQR 75–97) and discharge total FIM of 108.5 (IQR 103–118). For the other rehabilitation data, see **Table III**.

DISCUSSION

The objective of this study was to characterize the demographic and functional features of patients who were COVID-19-positive on admission to inpatient rehabilitation units in Toronto, Canada. The data presented here depict patients who were admitted to rehabilitation units

Table III. Rehabilitation data, $n = 41$

Rehabilitation data	Total
Rehabilitation Client Group, n (%)	
Medically complex	29 (70.7)
Pulmonary disorders	6 (14.6)
Stroke, ortho conditions, or debility	6 (14.6)
LOS, median (IQR)	16 (13–22)
Number of readmissions to acute, n (%)	2 (4.9)
Admission MoCA, median (IQR)	25 (20.75–25.00)
Admission FIM, median (IQR)	
Motor	53 (44–62)
Cognitive	32 (29–34)
Total	85 (75–97)
Admission diet, n (%)	
Regular	35 (85.4)
Modified	6 (14.6)
Transfer to another unit, n (%)	6 (14.6)
Discharge home, n (%)	35 (85.4)
Discharge FIM, median (IQR)	
Motor	77.5 (70.5–85.0)
Cognitive	34 (32–35)
Total	108.5 (103–118)
Discharge diet, n (%)	
Regular	39 (95.1)
Modified	2 (4.9)

IQR: interquartile range; LOS: length of stay; MoCA: Montreal Cognitive Assessment; FIM: Functional Independence Measure.

through specific admission criteria to support the acute care partner hospitals in the region. This paper therefore consolidates data from 41 patients admitted to 3 separate inpatient rehabilitation units in the city of Toronto, Canada, and reports on the impairments and functional changes in these patients through the provision of inpatient rehabilitation services.

Males and females were approximately equally represented in this study, however, there is increasing evidence that men infected with COVID-19 experience more severe symptoms and greater mortality (13, 14). It has also been shown that age is closely correlated with hospitalization and a more severe disease course (15, 16). This study cohort had a median age of 75 years. Furthermore, a number of comorbidities have been identified that are thought to play a role in COVID-19 complications (15, 17–20). Hypertension and diabetes were common comorbidities in this study, with 73.2% and 36.6% of individuals having these diagnoses, respectively. These comorbidities have previously been associated with susceptibility to COVID-19 infection (20, 21).

In the current study population, 36% of patients required admission to the ICU while in acute care, with or without mechanical ventilation. This proportion is in keeping with prior data on the percentage of overall acute care hospitalized patients with COVID-19 requiring ICU (17), although it is recognized that not all patients admitted to ICU will recover to a level appropriate for rehabilitation. As the objective of these recovery units was to transfer patients while still COVID-19-positive, but medically stable, cases with a prolonged acute care LOS and increased severity of disease may not have been captured in this specific data-set. A cross-sectional study by Curci et al. (7) reported that post-acute COVID-19 patients experienced dyspnoea with minimal activity, and reported severe disability. The authors reported that only a small fraction of patients were able to perform the 6-minute walk test (6-MWT), with poor results. Furthermore, a cross-sectional study by Weirtz et al. (22) characterized the clinical features of 60 individuals recovering from COVID-19 who were post-ICU and 1-week after discharge to rehabilitation. In their study they found 38.3% of all patients experienced exertion-induced oxygen desaturation, 72.7% had major muscle group weakness, and 21.7% had reduced mobility in 1 or both shoulders, 40% had dysphagia, and 39.2% reported symptoms of anxiety. An important difference between these studies and the current study was that all of their patients had had a previous ICU admission with respiratory support.

The current study also characterized affected body functions, according to the WHO classification (10). Neuromusculoskeletal function was affected in 73% of patients. This was largely indicative of the deconditioning effects of hospitalization due to COVID-19. The second most commonly affected body function was

“cardiovascular, haematological, immunological and respiratory”, with 65% of patients documented as having 1 of these body functions impacted by COVID-19. This included changes in respiratory status and, in some cases, thrombotic events; COVID-19 can be associated with a hypercoagulable state (23). Only 5 individuals (12.2%) had neurological complications, including critical illness neuromyopathy, encephalopathy, or seizures. While previous reports indicated high frequencies of delirium, stroke, and critical illness sequelae (8), data from the current study demonstrated relatively few patients with serious neurological complications. It is possible that the current study did not register such complications, given the retrospective study approach and the reliance on discharge summaries, which might have under-reported complications, such as delirium. Furthermore, the patients in this study had a median acute care LOS of 19 (12–31) days. One might expect that individuals who had a more prolonged hospitalization due to more severe disease, may have more extensive impairments.

The current study also explored a number of parameters commonly reported for patients undergoing inpatient rehabilitation, such as functional changes, as measured by the FIM, as well as comorbidities. Since many of the patients were elderly, with a number of comorbidities, they often required rehabilitation due to deconditioning from their admission to acute care hospitals, and were most in keeping with the profile of a typical medical or geriatric inpatient rehabilitation admission (24–26).

Median rehabilitation LOS was 16 days, and only 2 patients required readmission to acute care. The median total FIM was 85 at admission and 108.5 at discharge. Admitted patients demonstrated primarily motor-based FIM improvements (improving from a median of 53 on admission to 77.5 at discharge). In many cases, this relatively rapid improvement in mobility and motor function was what was required for successful discharge to home. There was also documented improvement in cognition, as measured by the FIM; median cognitive FIM was 32 on admission and 34 on discharge.

The development of COVID-19 recovery units in the city of Toronto occurred for a number of reasons. The most pressing reason during the initial phase of the pandemic was in anticipation of acute care beds being overburdened. Therefore, a specific set of admission criteria for patients who were anticipated to remain medically stable and continue their recovery in the rehabilitation setting was established. Admission criteria were also based on what we knew about the disease in the early phases of the pandemic and how to logistically and safely set up a recovery unit for rehabilitation candidates who were still testing positive for COVID-19. This is in contrast to the experience in New York, USA, where there was such tremendous overflow from acute care that some rehabilitation facilities were set up urgently for hospital bed space overflow (27). Indeed, in our hospitals, some patients who had lengthy

acute care stays as a result of COVID-19 were admitted to the most appropriate rehabilitation unit (as opposed to a designated COVID-19 recovery unit), as they had since tested negative. Therefore, patients with critical illness myoneuropathy would have been admitted to a general medical rehabilitation bed, and those who had a stroke would have been admitted to a stroke rehabilitation unit.

Study limitations

The primary limitation of this study is that it represents a focused group of individuals who were COVID-19-positive at the time they were admitted for rehabilitation. Therefore, a larger cohort of all patients admitted to rehabilitation with a history of COVID-19 would probably reflect a range of more serious functional impairments and long-term sequelae of the disease. As the objective of this study was to characterize the types of patients received across 3 sites based on pre-specified admission criteria, the current study was not designed to establish predictors of functional outcomes and serious disability in a heterogeneous population. This was recently studied in a group of hospitalized veterans, where Leigh et al. reported that patient age and indicators of severe COVID-19 infection, such as a new diagnosis of thrombosis, were more predictive of functional dependence at discharge from hospital than comorbidities present prior to infection (28). It should be noted the Leigh et al.'s study was not specific to a rehabilitation facility, but focused rather on hospitalized veterans admitted to acute care due to COVID-19. Since the current study relied on retrospective chart review, it was not able to assess a number of variables of interest. For instance, the rates of PTSD are reportedly very high in these patients, but there was no standardized assessment of this (3). Furthermore, as described above, some complications and affected body functions may be under-reported in the current study.

The findings of this study may also reflect the local conditions in the greater Toronto area, and may not be generalizable to other localities. Because there is vertical integration with acute care in each of the rehabilitation centres and because healthcare facilities report to the provincial Ministry of Health, there was strong coordination across sites of service delivery. The same may not be true in other regions.

These recovery units in Toronto were planned, and rehabilitative care was then delivered in the first wave of the pandemic. Since then, we have been in the midst of a second wave and the numbers of hospitalized patients has risen substantially. As a result of this study, we have some preliminary data on inpatient rehabilitation outcomes for patients who were admitted to inpatient rehabilitation facilities while still testing positive for COVID-19. This study represents some of the early data specific to the inpatient rehabilitation of individuals with COVID-19.

CONCLUSION

This study reports the characteristics and outcomes of COVID-19-positive individuals admitted to inpatient rehabilitation in Toronto, Canada early in the COVID-19 pandemic. It also describes key features of these rehabilitation inpatients, including affected body functions, FIM scores, and LOS. Further research, focussing on specific aspects of COVID-19-related disability, including the prevention and long-term management of COVID-19-related critical illness and disability, is necessary.

The authors have no conflicts of interest to declare

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