

Cognitive impairment and functional change in COVID-19 patients undergoing inpatient rehabilitation

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Cognitive impairment is increasingly recognized as a sequela of COVID-19. It is unknown how cognition changes and relates to functional gain during inpatient rehabilitation. We administered the Montreal Cognitive Assessment (MoCA) at admission to 77 patients undergoing inpatient rehabilitation for COVID-19 in a large US academic medical center. Forty-five patients were administered the MoCA at discharge. Functional gain was assessed by change in the quality indicator for self-care (QI-SC). In the full sample, 80.5% of patients exhibited cognitive impairment on admission, which was associated with prior delirium. Among 45 patients with retest data, there were significant improvements in MoCA and QI-SC. QI-SC score gain was higher in patients who made clinically meaningful changes on the MoCA, an association that persisted after accounting for age and delirium history. Cognitive impairment is frequent

among COVID-19 patients, but improves over time and is associated with functional gain during inpatient rehabilitation. *International Journal of Rehabilitation Research XXX: 000–000* Copyright © 2021 Wolters Kluwer Health, Inc. All rights reserved.

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Introduction

Cognitive impairment is increasingly recognized as a sequela of mild and severe COVID-19 infection [1–4]. However, it is still unclear how cognitive impairment after COVID-19 evolves and relates to functional outcomes. Cognition may improve in COVID-19 patients undergoing rehabilitation [5,6], but existing studies have not evaluated the association between cognitive change and functional gain, particularly in inpatient rehabilitation when early interventions can be implemented. Cognition is associated with functional gain in rehabilitation in other illnesses [7–9]. Determining whether such an association exists in the inpatient rehabilitation phase after COVID-19 could provide additional targets for early treatment to optimize outcomes.

The primary goal of the present study was to evaluate change in cognition and its relation to functional gain among COVID-19 patients undergoing inpatient rehabilitation. A secondary goal was to add to a growing body of literature that describes the frequency, severity, and predictors of cognitive impairment after COVID-19.

Methods

Participants

Ninety-four patients with COVID-19 were admitted to an inpatient rehabilitation unit in a US medical center from March to August 2020. Patients were medically

stable and able to tolerate 3 h/day of occupational, physical and speech-language therapy.

Seventeen patients were not administered our cognitive measure because (1) they were admitted prior to knowledge of COVID-19-related cognitive deficits and the implementation of our screening protocol; (2) clinicians deemed it could not be reliably administered due to language barriers; or (3) clinicians deemed patients were cognitively intact.

Data were extracted from retrospective chart reviews under the approval of the Weill Cornell Medicine Institutional Review Board. 19/77 patients underwent a separate neuropsychological evaluation during their admission, the results of which have been published [5]; the results described here are novel.

Outcome measures

Data extracted included age, sex (men or women), prior level of function (independent or not), intubation history (yes or no) and length (in days), delirium history (yes or no) and inpatient rehabilitation and acute hospitalization lengths of stay (Table 1).

The Montreal Cognitive Assessment (MoCA) [10] was administered within 72 h of admission to inpatient rehabilitation. Scores on the MoCA range from 0–30 and ranges indicate ≥26 = normal, 18–25 = mild impairment,

Table 1 Demographic and clinical characteristics (N [%] or mean [SD])

	N = 77 (Full sample)	N = 45 (Patients with discharge MoCA)	N = 32 (Patients without a discharge MoCA)
Sex			
Men	49 (63.6%)	30 (66.7%)	19 (59.4%)
Women	28 (36.4%)	15 (33.3%)	13 (40.6%)
Age	61.03 (15.67)	61.98 (14.11)	59.69 (17.77)
Independent prior to hospitalization	74 (96.1%)	44 (97.8%)	30 (93.8%)
Acute hospitalization length of stay	37.03 (31.8)	39.4 (34.11)	33.69 (28.4)
Inpatient rehabilitation unit length of stay	13.43 (6.47)	14.44 (6.06)	12 (6.84)
Documented delirium	44 (57.1%)	28 (62.2%)	16 (50%)
Intubated	59 (76.6%)	35 (77.8%)	24 (75%)
Intubation length	13.31 (10.53)	13.75 (10.03)	12.67 (11.37)
Documented hypoxia	69 (89.6%)	39 (86.7%)	30 (93.8%)
History of neurological diagnosis	2 (2.6%)	1 (2.2%)	1 (3.1%)
Initial MoCA scores	20.29 (5.47)	17.96 (4.71)	23.47 (5.06)
Discharge MoCA scores		22.02 (4.23)	
Initial QI-SC score	25.75 (6.21)	24.96 (4.94)	26.88 (7.59)
Discharge QI-SC score	36.57 (8.37)	37.11 (6.97)	35.81 (10.09)

11–17 = moderate impairment and ≤ 10 = severe impairment. The minimal clinical important difference (MCID) of 3 points was used [11]. Three patients received the Blind MoCA, which was converted to a 30-point scale per established guidelines. The Blind MoCA is a 22-point version of the original MoCA that is modified for vision-impaired individuals by removing visually based items, that is, items from the visuospatial/executive and naming domains. Discharge MoCA was administered to 45/77 patients. Thirty-two patients did not receive a discharge MoCA as they either scored normal on the initial assessment, were unavailable, and/or declined.

The quality indicator for self-care (QI-SC) [12,13] is part of the Inpatient Rehabilitation Facility-Patient Assessment Instrument, a standard functional assessment in the United States. The QI-SC is composed of seven items, which include eating, oral hygiene, toileting, bathing, upper body dressing, lower body dressing, and putting on/taking off footwear. Each item is scored on a 1–6 scale by the patient's occupational therapist, depending on the level of assistance that is required for the patient to complete the functional task. Higher scores represent less assistance required. A score of 1 indicates 'dependent' and 6 indicates 'independent'. The QI-SC total score ranges from 7–42. As the QI-SC is a relatively new measure, no cutoff scores are currently available, and we, therefore, used the total score as a continuous variable in analyses.

Statistical analyses

We used descriptive statistics to describe the frequency of cognitive impairment. We used independent and paired-samples *t* tests with effect sizes (Cohen's *d*), and Spearman rank-order correlations, to evaluate associations between clinical characteristics and admission

MoCA, change in MoCA and QI-SC from admission to discharge and QI-SC change in patients who met or did not meet the MoCA MCID. To adjust for age and to account for the effect of multiple variables, we used multivariable linear regression models.

Results

Table 1 provides demographic and clinical data. Patients with discharge MoCA scores ($n = 45$) did not differ from those who were not administered the MoCA at discharge ($n = 32$) in age, sex, prior neurologic history, prior delirium, prior intubation or prior hypoxia (all $P > 0.05$).

Cognitive impairment at admission to rehabilitation

62/77 patients (80.5%) demonstrated cognitive deficits on the MoCA at admission: 39/77 (51%) had mild deficits, 20/77 (26%) had moderate deficits and 3/77 (4%) had severe deficits.

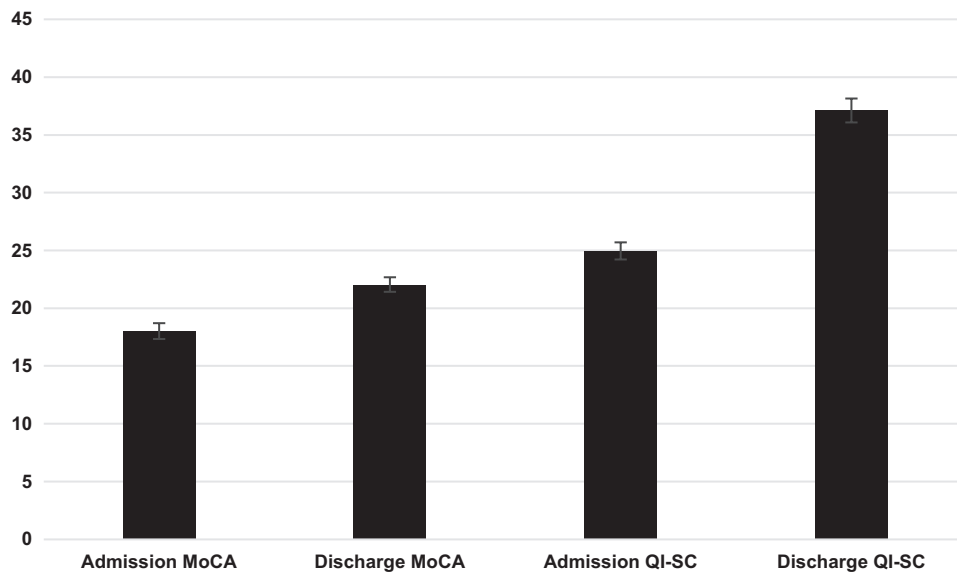
Correlates of cognitive impairment at admission to rehabilitation

Admission MoCA scores were lower for patients who previously had delirium (mean difference = 3.08, 95% confidence interval [CI], 0.58–5.58, $t = 2.45$, $P = 0.02$, $d = 0.58$). Admission MoCA scores were not correlated with age ($r = -0.15$, $P = 0.19$), length of intubation ($r = -0.04$, $P = 0.72$), or acute hospitalization length of stay ($r = -0.08$, $P = 0.50$). In a multivariable linear regression predicting admission MoCA from age, history of delirium, length of intubation, and length of acute care hospitalization, the overall model was significant ($R^2 = 0.13$, $F = 2.53$, $P = 0.049$). Among predictors, only history of delirium had a significant association with admission MoCA ($\beta = -3.67$, $t = 2.35$, $P = 0.02$).

Change in cognition and association with functional gain

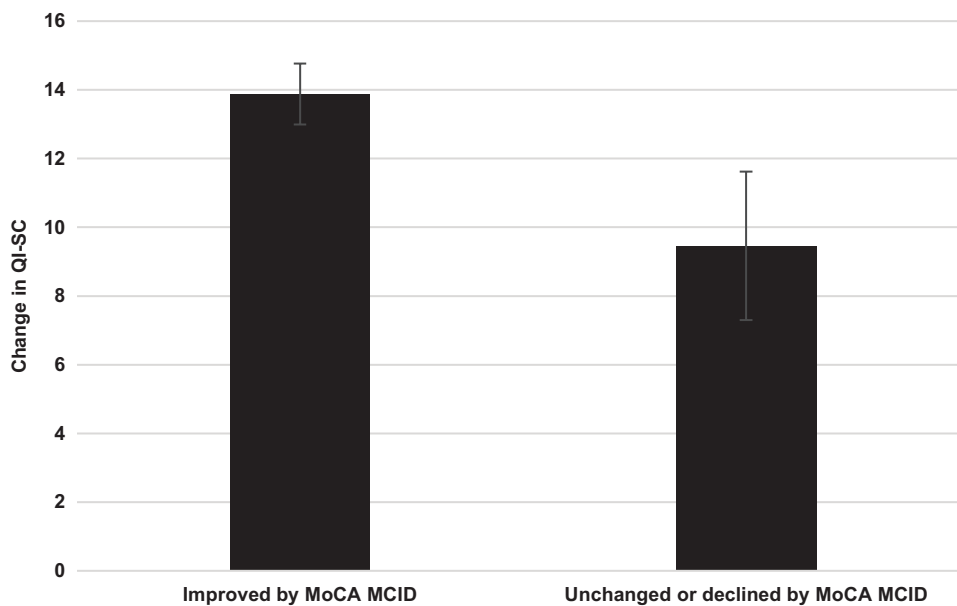
The 45 patients with admission and discharge MoCA scores improved on the MoCA (mean difference = 4.02, 95% CI, 2.92–5.13, $t = 7.35$, $p < 0.001$, $d = 1.10$) and QI-SC (mean difference = 12.16, 95% CI, 10.3–14.01, $t = 13.19$, $p < 0.001$, $d = 1.97$) (Fig. 1). 32/45 patients (71%) met the MoCA MCID. There was a greater increase in QI-SC scores in patients who met the MoCA MCID than those who did not (mean difference = 4.41, 95% CI, 0.49–8.34, $t = 2.27$, $P = 0.03$, $d = 0.75$; Fig. 2). To evaluate the robustness of this association, we conducted a multivariable linear regression with the outcome of QI-SC score change and predictors of MoCA MCID (met or did not meet/declined), age and history of delirium. While the overall model was not statistically significant ($R^2 = 0.13$, $F = 2.03$, $P = 0.125$), among individual predictors, improvement by the MoCA MCID continued to have a significant association with QI-SC score change ($\beta = 4.74$, $t = 2.31$, $P = 0.03$) after adjusting for age and history of delirium. Despite overall improvement, at discharge, 35/45 patients (78%) continued to exhibit cognitive impairment on the MoCA.

Fig. 1



Mean scores on the MoCA and QI-SC at admission and discharge in $N = 45$ patients with full data. Error bars represent SEM. MoCA, Montreal Cognitive Assessment; QI-SC, quality indicator for self-care.

Fig. 2



Change in functional self-care ability by clinically meaningful cognitive improvement. Error bars represent SEM.

Discussion

Our main findings are (1) cognitive impairment is common in COVID-19 patients undergoing inpatient rehabilitation and associated with a history of delirium; (2) cognition and function (self-care) improve significantly during inpatient rehabilitation; and (3) clinically meaningful

gains in cognition are associated with improved functional gains.

COVID-19 patients exhibited significant improvement in cognition with a large effect size. Cognitive improvement over time may reflect natural recovery, improvement in

residual effects of prior delirium, and/or rehabilitation intervention effects. Our results indicate that cognition evolves after COVID-19 and suggests that it may be beneficial to implement cognitive interventions to facilitate functional recovery [5]. Despite the recovery, a majority of our sample continued to demonstrate cognitive impairment at discharge from inpatient rehabilitation, highlighting the importance of continued management of cognition postdischarge [6].

COVID-19 patients also experienced a significant improvement in their functional self-care skills. Notably, significantly greater functional improvement was seen in patients who exhibited a clinically meaningful improvement in cognition. Although we cannot make causal conclusions, these findings suggest that addressing cognitive impairment after COVID-19 may improve functional outcomes.

Consistent with prior research, we replicate findings of a high frequency of cognitive impairment, predominantly mild impairment, in recovering COVID-19 patients. Also consistent with the literature on the negative consequences of delirium after COVID-19 [14–16], delirium during acute hospitalization was associated with greater cognitive impairment at admission to rehabilitation. This emphasizes the potential importance of early detection and management of delirium after COVID-19.

Among the limitations of this study, discharge cognitive data were not available for 32/77 patients, which may have biased findings. However, there were no demographic or clinical differences between the 45 patients with and 32 patients without discharge cognitive data. Missing data highlight challenges of administering objective cognitive assessments in an acute inpatient setting, particularly during a time in which the cognitive sequelae of COVID-19 were relatively unknown and hospital policies and procedures were rapidly evolving at the initial surge of the pandemic. Prospective longitudinal research is necessary to estimate the true prevalence of cognitive dysfunction, its evolution posthospitalization, and to ascertain etiological mechanisms. Our sample comprised a relatively sick group of patients from the first wave of COVID-19; findings may not apply to milder disease presentations or from subsequent waves of illness.

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Conflicts of interest

There are no conflicts of interest.

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