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Patients Surviving Critical COVID-19 have Impairments in Dual-task Performance Related to Post-intensive Care Syndrome

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Abstract

Objective: The purpose was to examine Dual Task (DT) performance in patients surviving severe and critical COVID-19 compared to patients with chronic lung disease (CLD). Secondarily, we aimed to determine the psychometric properties of the Timed Up and Go (TUG) test in patients surviving COVID-19. **Design:** Prospective, cross-sectional, observational study. **Setting:** Academic medical center within United States. **Patients:** Ninety-two patients including 36 survivors of critical COVID-19 that required mechanical ventilation (critical-COVID), 20 patients recovering from COVID-19 that required supplemental oxygen with hospitalization (severe-COVID), and 36 patients with CLD serving as a control group. **Measurements and Main Results:** Patients completed the TUG, DT-TUG, Short Physical Performance Battery (SPPB), and Six Minute Walk Test (6MWT) 1-month after hospital discharge. A subset of patients returned at 3-months and repeated testing to determine the minimal detectable change (MDC). Critical-COVID group (16.8 ± 7.3) performed the DT-TUG in significantly slower than CLD group (13.9 ± 4.8 s; $P = .024$) and Severe-COVID group (13.1 ± 5.1 s; $P = .025$). Within-subject difference between TUG and DT-TUG was also significantly worse in critical-COVID group (−21%) compared to CLD (−10%; $P = .012$), even despite CLD patients having a higher comorbid burden ($P < .003$) and older age ($P < .001$). TUG and DT-TUG demonstrated strong to excellent construct validity to the chair rise test, gait speed, and 6MWT for both COVID-19 groups ($r = −0.84$to 0.73, $P < .05$). One- and 3-months after hospital discharge there was a floor effect of 14% (n = 5/36) and 5.2% (n = 1/19), respectively for patients in the critical-COVID group. Ceiling effects were noted in four (11%) critical-COVID, six (30%) severe-COVID patients for the TUG and DT-TUG at 1-month. **Conclusion:** The ability to maintain mobility performance in the presence of a cognitive DT is grossly impaired in patients surviving critical COVID-19. DT performance may subserve the understanding of impairments related to Post-intensive care syndrome (PICS) for survivors of critical illness.

Keywords

COVID-19, post intensive care syndrome, mobility, intensive care, physical function

Introduction

Patients surviving acute respiratory failure (ARF) may develop symptoms or impairments in the physical, cognitive, and emotional domains of health which leads to poor Health-related Quality of Life (HRQoL).[1–4] Post-intensive care syndrome (PICS) is the confluence of symptoms or impairments which manifest or are exacerbated after critical illness.[5] The coronavirus disease (COVID-19), has and continues to be a major contributor to intensive care unit (ICU) admissions for ARF.[6] Individuals surviving ARF due to COVID-19 are at risk of developing impairments related to PICS leading to morbidity, delayed return to work, unplanned rehospitalization and poor HRQoL.[7–11] Research demonstrates that survivors of ARF may have structural and functional alterations within the central nervous system (CNS)

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responsible for both cognitive function and motor control.[12–14] These findings indicate that survivors of critical illness potentially exhibit alterations in CNS function which impose functional implications across a variety of settings. Therefore, investigations regarding multifaceted patient outcomes are essential to understand recovery and develop interventions to improve outcomes.

Traditional clinical assessment of impairments related to PICS may utilize a battery of cognitive and motor outcomes completed separately in succession.[15] However, numerous occupational duties and activities of daily living require the concurrent or "dual" completion of cognitive and motor tasks. Thus, current PICS-related assessments may lack criterion validity for real-world environmental interaction.[16] Dual-task (DT) assessments (ie, the concurrent completion of a cognitive and motor task) offer an avenue for capturing vital daily functioning.[17] Decreased DT performance during gait and balance tasks is associated with fall risk and poor quality of life in neurological and geriatric populations.[18–25] Prior studies have identified decreased DT gait and balance performance in chronic respiratory disorders,[26–28] but are relatively unexplored in patients with and surviving ARF.[29] Research and the media continue to highlight the potential for impairments in multi-tasking, cognitive fog, and decreased attention for patients recovering from COVID-19.[30,31] There are, however, no findings of DT gait and balance outcomes in critical COVID-19 survivors, which may be an important barometer of function and recovery.

The primary purpose of this study was to determine if patients recovering from severe and critical COVID-19, demonstrate DT mobility deficits comparable or worse than individuals with chronic lung disease (CLD) without a history of COVID-19. Secondarily, we aimed to determine the validity of the Timed Up and Go (TUG) test and dual-task TUG (DT-TUG), which are clinical measures of mobility and cognition, in patients recovering from severe and critical COVID-19. Additionally, 1-month after hospital discharge floor and ceiling effects of the TUG and DT-TUG were derived. We hypothesized that critical COVID-19 survivors, who received mechanical ventilation (MV), will demonstrate significantly worse DT performance compared to those with CLD or severe COVID-19 survivors that did not require MV.

Methods

Ethics

The study was approved by the internal review board at the University of Kentucky (MEDXP #59097). Patients provided informed written consent. This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE, Supplemental File) and Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) guidelines[32,33]

Study Design

A prospective, cross-sectional, observational study with a convenience sampling was conducted with adult patients (≥ 18 years old) from August 1, 2020, to July 15, 2021 in outpatient academic medical clinic.

Participants

Three groups of patients were included in the study:

1. Critical-COVID[34]: patients surviving COVID-19 that required >24 h of MV via endotracheal tube, that attended routine medical follow-up at the ICU Recovery Clinic approximately 1-month after hospital discharge.[35]
2. Severe-COVID[34]: patients recovering from COVID-19 that required an acute hospitalization and supplemental oxygen (high-flow nasal cannula, venturi mask, and/or nasal cannula) were eligible for study if they attended the ICU Recovery Clinic or the outpatient pulmonary rehabilitation approximately 1 month after hospital discharge.
3. CLD: patients with COPD and interstitial lung disease attending routine care in pulmonary rehabilitation were enrolled to serve as a comparator group. Patients were excluded if they had a hospitalization in last 12-months or history of COVID-19.

At the baseline testing, there were no missing data for patients enrolled in the study. Nineteen (critical-COVID) and 9 (severe-COVID) patients included in this study were co-enrolled in a nonrandomized rehabilitation intervention cohort study[36,37] and thus had data available at two-time-points (1-month and 3-months post discharge). Patients were excluded from all three groups if they had an acute or chronic neurologic, neurodegenerative, or orthopedic condition or disease that influenced cognition or motor performance. One of 2 trained physical therapists performed outcome measures.

Primary Patient Outcomes:

Timed-Up-and-Go (TUG) and DT TUG: The TUG is a reliable and valid measure of mobility[38,39] The DT-TUG is a complimentary component that assesses ability to perform motor and cognitive task simultaneously.[40] Deficits in TUG have previously been reported in survivors of critical illness[41,42] but DT-TUG has not been studied in this population. The TUG requires patients to stand up from a chair, ambulate 3 m, turn around a cone, ambulate back to the chair, and return to a seated position. For the DT-TUG, patients were required to complete a serial subtraction task while performing the TUG. DT cost (DTC), a measure representing the percentage change from TUG to DT-TUG, was calculated using the following equation: DTC-TUG = [(Dual-task Performance − Single Task Performance)/Single Task Performance] × 100.[43,44]

Secondary Patient Outcomes

Patients completed the Short Physical Performance Battery (SPPB), Six Minute Walk Test (6MWT), Montreal Cognitive

Assessment (MOCA), and the EuroQol-5Dimension-5L (EQ-5D-5L). SPPB is a lower-extremity physical function assessment with lower scores indicating mobility deficits.[45–49] A score of 8 or lower was used to categorize patient with mobility and balance deficits. Patients completed the 6MWT, per the American Thoracic Society guidelines[50] and percentage of predicted distances were calculated.[51] The Clinical Frailty Scale was scored by the physical therapist.[52,53]

Demographic and Clinical Variables

Were extracted from electronic health record for patients in COVID groups including: age, sex, body-mass index (BMI), race/ethnicity, comorbidity status (Charlson Comorbidity Index [CCI]), receipt of sedative medication (yes or no), severity of illness measured by Sequential Organ Failure Assessment scores (SOFA),[54] mechanical (yes or no) and duration, supplemental oxygen modality (high-flow nasal cannula [HFNC], venturi mask, and nasal cannula), length of ICU and hospital stay, and discharge destination. Age, sex, BMI, race/ethnicity, and CCI was extracted for patients in CLD group.

Statistical Analysis

A total sample of 66 subjects, with a minimum of 18 in each group, is needed to detect differences between 3 groups with an effect size (f) = 0.8 using ANOVA with fixed effects, 0.95 power, and significance of $P = .05$ (G*Power 3.1.9.2, Franz Faul, Germany). Descriptive statistics and normality (Kolmogorov-Smirnov test) were performed. ANOVA, Kruskal-Wallis test, and chi-square analyzes were performed to assess differences in continuous and discrete variables respectively. ANOVA or Kruskal-Wallis test using Bonferroni correction for pairwise comparisons were used to assess group differences in primary and secondary outcomes between the 3 groups. Spearman rho coefficients were used to determine the criterion validity of the TUG and DT-TUG compared to MOCA as well as the construct validity compared to secondary physical function measures both COVID groups.[48] Correlations were interpreted as little (0.00-0.25), fair (0.25-0.50), moderate (0.50-0.75), and excellent relationship (>0.75).[55] The minimal detectable change (MDC) was calculated for TUG, DT-TUG, and DTC-TUG for only the subset of patients completing measures at two timepoints. The MDC was calculated as: 1.96 – Standard Error of Measurement (SEM) $\times \sqrt{2}$. SEM was calculated as $\sigma_1\sqrt{1-r}$. Where σ_1 represents the baseline SD of the test score and r was the test-retest reliability coefficient of the test.[56] The minimal important difference (MID) of TUG and DT-TUG were calculated from a distribution-based estimate of SEM and effect size (ES). ES was calculated as 0.5 × SD of change scores.[57] Floor effect was determined as the percentage of participants who were unable to complete TUG and DT-TUG, and considered significant if ≥15% of patients were unable to complete the test.[58] Ceiling effect for the TUG was defined as ≤8.5 s[59] and ≤9.8 s for the DT-TUG.[60] Significance was set a-priori at $P = .05$. All statistics were completed in SPSS version 25 (IBM, Armonk, NH).

Results

Ninety-two patients participated in the study: 36 survivors of critical COVID-19, 20 patients surviving severe COVID-19, and 36 patients with CLD (Table 1). Patients in the critical-COVID group were significantly younger (mean age = 55.6 ± 12.2) and had less comorbid burden (median CCI scores = 3 [1-4]) compared to patients in the CLD group (mean age 66.4 ± 10.5 years, p <.001; and median CCI = 4 [3-6], $P = .003$). There were no differences in sex or race between the three groups (Table 1). Patients in the critical-COVID had a SOFA score of 11.7 ± 2.2 at ICU admission with average duration of MV lasting 16.3 ± 9.0 days. The severe-COVID group had a SOFA score of 3.4 ± 1.4 at hospital admission and 14 patients (71%) requiring HFNC (Table 1). Twenty of 34 (59%) critical-COVID and eight of 13 (62%) Severe-COVID patients who completed the MOCA met diagnosis of MCI.[61] Twenty-one (60%) critical-COVID and eight (40%) severe-COVID patients demonstrated SPPB scores below the cutoff score for mobility impairments (Table 2). Thus, thirty-one (86%) of critical-COVID and twelve (60%) severe-COVID patients demonstrated either a physical or cognitive indicative of an impairment related to PICS 1-month after hospital discharge.

TUG, DT-TUG, and DTC-TUG

Patients in critical-COVID group performed TUG and DT-TUG in mean 15.0 ± 8.5 and 17.1 ± 7.3 s, respectively, equating to –20% DTC-TUG. Patients in the critical COVID group had the slowest times to complete TUG and DT-TUG and highest DTC (Table 2). Statistically, the difference between the three groups for TUG was not significant ($F = 2.8$, $P = .067$, Table 2). A significant group effect was found for DT-TUG times between the three groups ($F = 5.1$, $P = .009$) with pairwise comparisons, determining critical-COVID to have slower DT-TUG times than severe-COVID ($P = .025$) and CLD ($P = .024$, Figure 1). A significant group effect was found for DTC-TUG ($F = 4.7$, $P = .012$) with pairwise comparisons revealing that critical-COVID patients have greater DTC-TUG than patients with CLD ($P = .012$) but not severe-COVID ($P = .136$, Figure 1). Importantly, these findings were found despite the CLD cohort group being significantly older and having greater comorbidities. Fifteen patients (44%) in critical-COVID group and 4 (20%) Severe-COVID patients demonstrated DT-TUG times above the clinical cutoff score for fall risk (ie, >15 s).[62]

Construct and Criterion Validity

The TUG and DT-TUG times demonstrated moderate to strong correlations with measures of physical function and frailty outcomes in patients in critical-COVID (Table 3)

Table 1. Demographic and Clinical Information.

Demographics variables	Critical-COVID n = 36	Severe-COVID n = 20	CLD n = 36	P-value[1]
Age, mean (SD)	55.7 (12)	57.7 (11)	66.2 (10.4)	<.001
Female, n (%)	15 (41)	10 (50)	19 (51)	.737
Race, n (%)				
White	18 (49)	14 (70)	28 (76)	.181
Black	14 (38)	4 (20)	8 (22)	
Hispanic/Latino	5 (14)	2 (10)	1 (2)	
BMI, mean (SD)	36.8 (8.9)	35.8 (6.9)	30.8 (6.7)	.712
CCI, median [IQR]	3 [1 to 4]	2.5 [2 to 4]	4 [3 to 6]	.021
Acute illness parameters				
SOFA, median [IQR]	12 [10 to 13]	[2 to 4]		
MV via ETT, yes, n (%)	36 (100)	0 (0)		
MV via ETT, duration, days, mean (SD)	16.3 (9)			
HFNC, yes, n (%)	21 (58)	12 (60)[2]		
HFNC duration, days, mean (SD)	3.4 ± 2.2[3]	6.7 (5)		
Binomial ICU variables, yes, n (%)				
Steroid	32 (83)	11 (55)		
Vasopressor/inotrope	28 (76)	–		
NMB	21 (57)	–		
CRRT	9 (24)	–		
ECMO	5 (14)	–		
Tracheostomy	15 (41)	–		
ICU LOS, mean (SD)	22.9 (12.5)	8.2 (4.8)		
Hospital LOS, mean (SD)	32.6 (13.3)	10.8 (6)		
Discharge destination, n (%)				
Long-term acute care	2 (5.5)	-		
Acute rehabilitation	19 (53)	1 (5)		
Home with services	7 (19)	6 (30)		
Home without services	8 (22)	13 (65)		

Abbreviations: BMI, body mass index; CCI, Charlson Comorbidity Index; MV, mechanical ventilation; ETT, endotracheal tube; SOFA, Sequential Organ Failure Assessment; LOS, length of stay; ICU, intensive care unit; ECMO, Extracorporeal Membrane Oxygenation; CRRT, Continuous Renal Replacement Therapy.

and severe-COVID (Table 4). In patients with severe-COVID, TUG and DT-TUG demonstrated moderate criterion validity against MOCA ($r = -0.66$, $P = .014$; $r = -0.67$, $P = .012$ respectively, Table 4).

Responsiveness

Five (14%) patients in the critical-COVID group were unable to complete the TUG due to inability to stand from chair. One additional patient was unable to complete DT-TUG after successfully completing the TUG due to significant loss of balance requiring assistance (n = six, 17% for DT-TUG) 1-month after hospital discharge. The floor effect for patients in the severe-COVID group was 0% and 3% (1/36) for the CLD group. Ceiling effects were noted in four (11%) critical-COVID and six (30%) severe-COVID patients for the TUG and the DT-TUG at 1-month after discharge. Five (14%) CLD patients demonstrated ceiling effects during the TUG and DT-TUG.

Nineteen patients and nine patients in critical- and severe-COVID groups that repeated testing demonstrated improvement in TUG from 1 month to 3-months post discharge (Supplemental Table 1). The MDC for TUG, DT-TUG, and DTC-TUG in critical-COVID group was 4.6 s, 5.8 s, and −15.7% respectively. The MID for the TUG and DT-TUG was between 2.6 to 3.24 and 3.0 to 4.1 s respectively for critical-COVID. The MDC for TUG, DT-TUG, and DTC-TUG for nine patients in the severe-COVID was 1.6 s, 1.9 s, and 7.8% respectively. The MID for the TUG, and DT-TUG was 0.83 to 1.11 and 0.73 to 1.33 s respectively for severe-COVID.

Discussion

Patients surviving critical COVID-19 that required MV in our study demonstrate worse performance on a DT assessment when compared to patients with CLD and patients surviving severe COVID-19. DT deficits in survivors of COVID-19 were captured by the TUG, a quick and clinically feasible test. Interestingly, there were no statistical differences on single-task TUG between groups, but significant differences were noted in DT-TUG. This may suggest that DT assessment is sensitive for detecting impairments in higher-order mobility functioning in survivors of critical illness. Thus, the current clinical approach of assessing cognitive and motor function independently may fail to identify the interaction between

Table 2. Physical, Cognitive and Quality of Life Outcomes.

Physical outcomes	Critical-COVID	Severe-COVID	CLD	*P*-value
TUG (s)	15.0 (8.5)	11.3 (3.9)	12.4 (3.5)	.067
DT-TUG (s)	17.1 (7.3)[a,b]	12.9 (4.8)	13.3 (3.6)	.009
DTC TUG (%)	−19.9 (16.7)[b]	−11.9 (11.5)	−9.5 (11.5)	.012
Chair Rise Test (s)	14.8 (6.4)	14.7 (8.4)	13.1 (3.9)	.919
Gait Speed (m/s)	0.73 (0.26)[a,b]	0.93 (0.3)	0.92 (0.3)	.005
SPPB Total (0-12)	6.9 (3.8)[a,b]	9.1 (3.)	9.1 (2.6)	.009
6MWD, meters	184 (135)[a,b]	291 (128)	261 (97)	.007
6 MWT, %	40 (24.4)[a,b]	58 (25.7)	53.9 (20.2)	.002
CFS (0-10)	5 (0.9)[a,b]	3.5 (1.2)	3.7 (0.7)	<.001
Cognitive & quality of life outcomes	Critical-COVID	Severe-COVID	*P*-value	
MOCA (0-30)	24.3 (3.8)	24.1 (3.2)	.738	
EQ-5D—VAS (0-100)	70.6 (17.7)	70.1 (19.1)	.859	

[a]Significantly different from Severe-COVID.
[b]Significantly different from CLD.

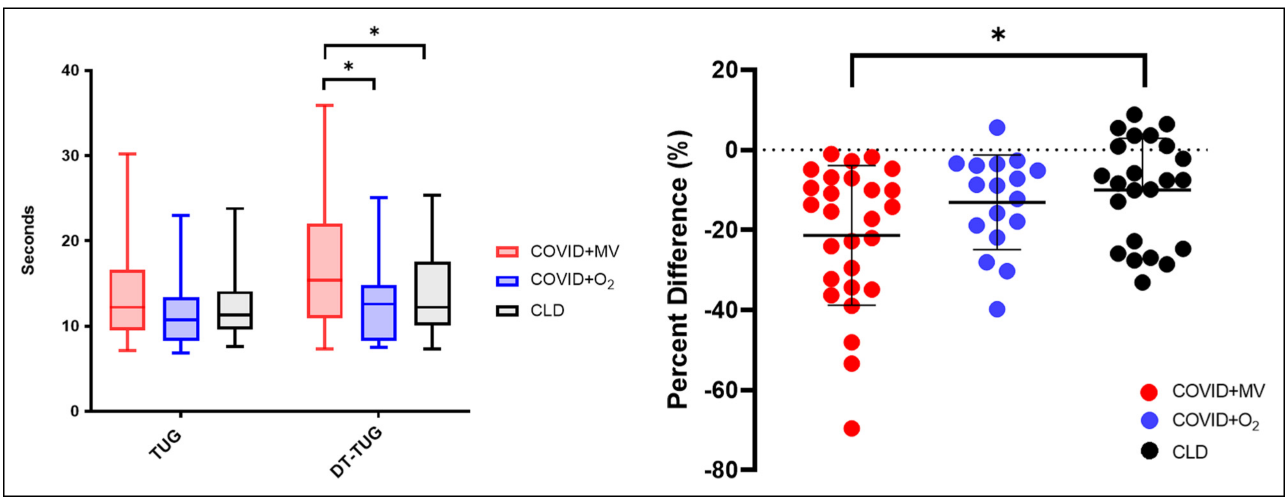

Figure 1. Physical function and dual-task performance in severe and critical COVID-19 survivors. Panel A: Box and whisker plots of patient averages for the TUG and DT-TUG. Pairwise comparisons determined Critical-COVID to have greater DT-TUG times than Severe-COVID ($P = .025$) and CLD ($P = .024$). Panel B: The relative percent difference between TUG and DT-TUG, also called DTC TUG for each patient group. A significant group effect was found for DTC-TUG ($F = 4.7$, $P = .012$). Pairwise comparisons determined Critical-COVID patients to have greater DTC-TUG than patients with CLD ($P = .012$) but not Severe-COVID ($P = .136$).

cognitive and motor deficits. The data contained herein are novel and strongly suggest that acute critical illness due to COVID-19 leads to a high risk of an interaction between cognitive and motor deficits in the acute recovery periods. The findings emphasize the need to assess and treat impairments related to multi-tasking in survivors of critical illness.

Patients surviving critical COVID-19 performed worse or similar on TUG and DT-TUG to normative measures in older adults, approximately 20 years older than the current cohort.[60] Clinically, a time of >15 s on the DT-TUG leads to a high risk of falling.[62] Thus, majority of the critical-COVID patients in our study would be considered to have a high risk of falling and subsequent morbidity. Our study also demonstrates that critical COVID-19 survivors have worse physical and DT performance than patients with CLD. Interestingly, these differences were present despite the fact the CLD cohort was an average of 10 years older and had significantly higher co-morbid burden. Preliminary interpretation of the data may suggest that this is a limitation of the study (not comparing to age matched controls). However, patients with CLD are known to have a greater extent of DT deficits than age matched controls, therefore, findings suggest that severe and critical COVID-19 may lead to significant deficits in physical function and DT task performance. To our knowledge, this is the first study to assess DT performance in survivors of critical COVID-19 and may also be the first in patients surviving critical illness of any etiology. The findings of this study suggest patients with a single severe pulmonary illness event, such as

Table 3. Correlations of TUG, DT-TUG, and DTC TUG to Mobility and Frailty Outcome Measures in Patients with Critical-COVID.

		TUG	DT TUG	DTC TUG
Chair Rise Test	ρ	**0.67**	**0.61**	−0.03
	P-value	**.001**	**.003**	.889
	N	21	21	21
Gait Speed	ρ	**−0.82**	**−0.75**	0.148
	P-value	**<.001**	**<.001**	.452
	N	25	28	28
SPPB	ρ	**−0.84**	**−0.81**	0.23
	P-value	**<.001**	**<.001**	.220
	N	30	30	30
CFS	ρ	**0.73**	**0.72**	−0.330
	P-value	**<.001**	**<.001**	.075
	N	30	30	30
6MWD	ρ	**−0.77**	**−0.65**	0.069
	P-value	**<.001**	**<.001**	.749
	N	25	25	25
MOCA	ρ	0.028	−0.003	0.24
	P-value	.884	.987	.213
	N	28	28	28

Abbreviations: SPPB, Short Performance Physical Battery; CFS, Clinical Frailty Scale; 6MWD, Six Minute Walk Test Distance; MOCA, Montreal Cognitive Assessment. Bold correlations are significant.

Table 4. Correlations of TUG, DT TUG, and DTC TUG to Mobility and Frailty Outcome Measures in Patients with Severe-COVID.

		TUG	DT TUG	DTC TUG
Chair Rise Test	ρ	0.45	**0.59**	**−0.74**
	P-value	.072	**.013**	**<.001**
	N	17	17	17
Gait Speed	ρ	**−0.72**	**−0.68**	0.23
	P-value	**<.001**	**<.001**	.444
	N	20	20	20
SPPB	ρ	**−0.73**	**−0.75**	**0.50**
	P-value	**<.001**	**<.001**	**.026**
	N	20	20	20
CFS	ρ	**0.57**	**0.60**	−0.11
	P-value	**.008**	**.006**	.685
	N	20	20	20
6MWD	ρ	**−0.68**	**−0.67**	0.33
	P-value	**.001**	**.001**	.196
	N	20	20	20
MOCA	ρ	**−0.66**	**−0.67**	0.12
	P-value	**.014**	**.012**	.701
	N	13	13	13

Abbreviations: SPPB, Short Performance Physical Battery; CFS, Clinical Frailty Scale; 6MWD, Six Minute Walk Test Distance; MOCA, Montreal Cognitive Assessment. Bold correlations are significant.

COVID-19 requiring MV, express significant DT impairments after hospital discharge.

Impaired DT performance during the TUG in patients recovering from COVID-19 appears to be linked to critical illness severity. Namely, COVID-19 survivors who required only supplemental oxygen with lower index severity of illness demonstrated comparable performance across all three primary outcomes (ie, time to complete the TUG and DT-TUG, and DTC-TUG) to those with CLD. Conversely, patients with COVID-19 who required MV demonstrated significantly impaired DT performance even when compared to a patient population with known DT deficits, older age, and with more comorbidities (ie, CLD). The mechanisms underlying increased DT deficits in those surviving COVID-19 requiring MV is likely multifactorial in etiology, including muscular and CNS functional changes. Nonetheless, clinicians should account for disease severity factors when implementing and interpreting DT assessments.

To our knowledge, this is the first investigation to assess the psychometric properties of the TUG and DT-TUG in survivors of COVID-19. Our results show that the TUG and DT-TUG are valid measures of balance, gait speed, frailty, and walking distance in Severe-COVID and Critical-COVID survivors. Interestingly, TUG and DT-TUG performance was associated to gross cognitive function (ie, MOCA scores) in those with severe-COVID but not critical-COVID. The dissociation of cognitive function to TUG and DT-TUG was found despite both groups demonstrating similar performance on the MOCA and percentage of individuals who scored below the cutoff score for mild cognitive impairment. Minimal floor effects were found in patients severe-COVID and CLD, similar to previous findings in patients with COPD at 1 month after hospital discharge.[39] However, 14% of critical-COVID survivors were unable to perform the TUG or DT-TUG 1-month post discharge. Additionally, the MDC values reported here are of substantial value to clinical determinates of DT performance across time, or future intervention studies aiming to develop targeted rehabilitation strategies to address DT deficits in COVID-19. MDC values for single task TUG in patients who survived severe-COVID (3.8 s) are similar to prior reports in COPD (3.0 s).[63] The paucity of MDC values for DT-TUG in any patient population makes comparison difficult. Nonetheless, continued research is needed to confirm our findings, assess DT-TUG performance across multiple timepoints, and identify the relationship between DT-TUG and long-term patient outcomes in survivors of critical illness.

Several noteworthy limitations of this study merit discussion. First, cognitive performance of the serial subtraction task during DT-TUG was not collected. As such, this limits our ability to comment on the DTC of cognitive performance in this patient population. Second, while our analysis controlled for known factors of TUG performance, the presence of delirium in hospital was not controlled. We were unable to address delirium due to the heterogeneity of reporting in the EHR at our medical institution. Another limitation is the use of fall risk cut-off scores for DT-TUG that were derived from healthy older adults and not a clinical population. Therefore, our interpretations should be viewed with caution as we did not prospectively collect falls data. The pragmatic design with convenience sampling and no blinding of assessors are limitations that may introduced representation and selection biases.

The nature of the study to enroll only patients attending ICU Recovery Clinic and, or pulmonary rehabilitation may not capture the entire spectrum of COVID-19 survivors. It should be noted that an uneven distribution of enrollment in COVID groups may reduce statistical strength for group comparison, however, enrollment minimums determined by power analysis were obtained. Finally, the approach to study which included some patients participating in physical rehabilitation intervention may reduce the generalizability of the responsiveness data. We were unable to control for amount of physical rehabilitation received in hospital or acute rehabilitation facilities as well as the home environment, but this is representative of clinical practice. Physical rehabilitation is recommended after acute critical illness,[64] but significant heterogeneity exist in the delivery of treatment with a percentage of survivors rarely receiving consultation for rehabilitation.[65] Taken together, one of the strengths of our study is to encourage recognition of dual-task deficits which may further encourage consultation to physical rehabilitation.

Conclusion

This study demonstrates that patients recovering from critical COVID-19 have DT mobility deficits which was significantly worse than individuals with CLD. Moreover, the TUG and DT-TUG are valid measure of physical function in patients surviving COVID-19. Future investigations are needed to determine the association between DT-TUG performance and long-term outcomes.

Declaration of Conflicting Interests

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Ethical Approval

Not applicable, because this article does not contain any studies with human or animal subjects.

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Supplemental Material

Supplemental material for this article is available online.

Notes

1. Comparisons of means or counts between the three groups using ANOVA, Kruhalis Wallis, or chi-square tests.
2. Eight patients (40%) admitted to floor with supplemental oxygen via standard facial mask or nasal cannula.
3. Twenty one (58%) patients required HFNC before and, or after mechanical ventilation via ETT.

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