

NEUROIMAGE

# Long-Term Recovery from Disordered Consciousness Associated with COVID-19



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In July 2020, we first reported a prolonged disorder of consciousness associated with severe coronavirus disease 2019 (COVID-DoC) in a 47-year-old critically ill man who failed to reawaken after sedation was discontinued [1]. Despite structural brain abnormalities suggestive of hypoxic injury, he exhibited intact functional brain network connectivity (Fig. 1). Approximately 40 days after sedation was discontinued, he ultimately recovered consciousness, as demonstrated by command-following.

Others have since observed similarly prolonged COVID-DoC. In November 2020, a case report described a patient with COVID-DoC who recovered consciousness after 2 months [2], and a case series in December 2020 described six patients with COVID-DoC who recovered consciousness 8–31 days after sedation was discontinued [3]. *Neurocritical Care* published the first editorial describing the phenomenon of COVID-DoC, stating that “it is crucial to better understand the prognostic potential of COVID-19 patients who are slow to recover consciousness” [4].

These reports have provided preliminary data to inform immediate recovery from COVID-DoC. However, although patients with COVID-DoC may recover consciousness during the hospitalization, long-term outcomes (a crucial consideration in decisions about the continuation of life-sustaining treatment) have not been described.

Here we share the long-term outcome of the patient from our initial report. After regaining command-following on hospital day 61, he was discharged to an inpatient rehabilitation facility on hospital day 111. By discharge,

he was awake and oriented but profoundly weak, with antigravity strength in the upper extremities and trace activation in the lower extremities. Data from nerve conduction studies and needle electromyography were consistent with a critical illness myoneuropathy. After 161 days of inpatient rehabilitation and brief rehospitalizations for complications related to stage 4 sacral decubitus ulcers, he was discharged home.

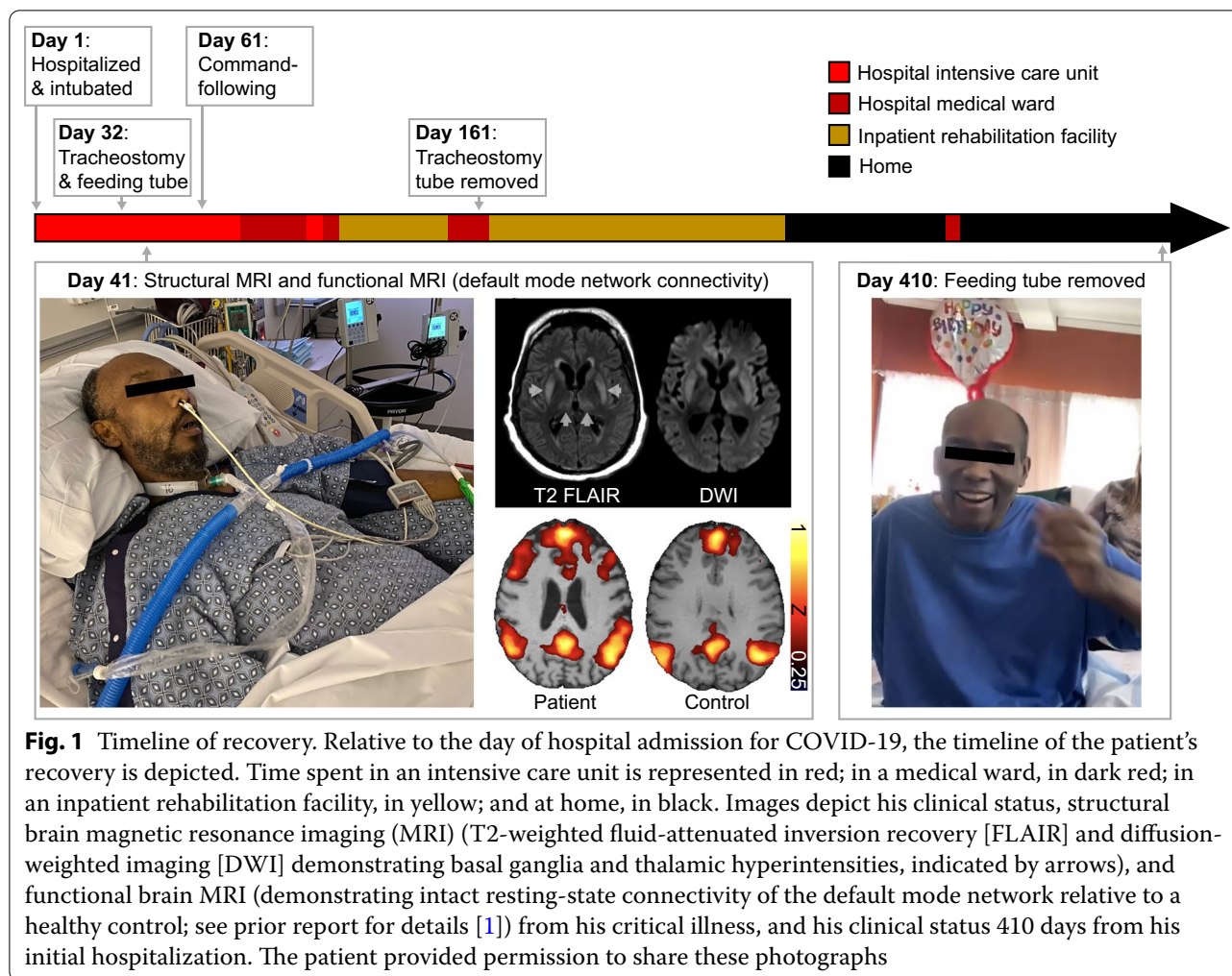
Four hundred ten days from his hospital admission for COVID-19, he remains at home with his wife (Fig. 1). His tracheostomy and feeding tubes have been removed. He demonstrates a nearly complete cognitive recovery, save for mild deficits in attention and memory: he is fully awake, alert, and oriented; he is conversational (although occasionally tangential); and he can follow complex commands, recite the months of the year backward (self-correcting one mistake), accurately perform calculations, and recall two of three words after a delay (recalling the third with cues). Although he is improving, persistent weakness has resulted in disability: at home he remains in bed, and although he can transfer to a wheelchair and stand for ~1 min with one- to two-person assistance, he requires supervision and support for activities of daily living. His modified Rankin Scale score is 5 (severe disability), his Glasgow Outcome Scale-Extended score is 3 (low severe disability), and his Disability Rating Scale score is 8 (moderately severe disability) [5]. Despite such physical disability, he is able to sit unsupported to interact with others (Supplemental Video, also available at <https://doi.org/10.6084/m9.figshare.16620067.v1>), and he reports, “I feel happy, because my family is here.”

This case illustrates that a robust cognitive recovery from COVID-DoC is possible, although the sequelae of prolonged critical illness may result in a protracted recovery and disability. Further research is necessary to elucidate the long-term outcomes following COVID-DoC.

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**Fig. 1** Timeline of recovery. Relative to the day of hospital admission for COVID-19, the timeline of the patient's recovery is depicted. Time spent in an intensive care unit is represented in red; in a medical ward, in dark red; in an inpatient rehabilitation facility, in yellow; and at home, in black. Images depict his clinical status, structural brain magnetic resonance imaging (MRI) (T2-weighted fluid-attenuated inversion recovery [FLAIR] and diffusion-weighted imaging [DWI] demonstrating basal ganglia and thalamic hyperintensities, indicated by arrows), and functional brain MRI (demonstrating intact resting-state connectivity of the default mode network relative to a healthy control; see prior report for details [1]) from his critical illness, and his clinical status 410 days from his initial hospitalization. The patient provided permission to share these photographs

#### Supplementary Information

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#### Author contributions

David Fischer and Brian Edlow conceived this study and wrote the manuscript, and the final manuscript was approved by both authors.

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#### Conflicts of interest

David Fischer reports no conflicts of interest. Brian Edlow reports no conflicts of interest.

#### Ethical approval/informed consent

This article adheres to ethical guidelines. Written consent was obtained from the patient and his family to share this report and included photographs.

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