

TITLE: Safety, Feasibility, and Outcomes of Frequent, Long-Duration Rehabilitation in an Inpatient Rehabilitation Facility After Prolonged Hospitalization for Severe COVID-19: An Observational Study

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Abstract:

Objectives. The objective of this study was to evaluate safety, feasibility, and outcomes of 30 patients within an inpatient rehabilitation facility following hospitalization for severe COVID-19 infection.

Methods. This was an Observational Study of 30 patients (ages 26-80) within a large, metropolitan academic hospital following hospitalization for complications from severe COVID-19. Ninety percent of the participants required critical care and 83% required mechanical ventilation during their hospitalization. Within an inpatient rehabilitation facility and model of care, frequent, long duration rehabilitation was provided by occupational therapists, physical therapists, and speech language pathologists.

Results. The average inpatient rehabilitation facility length of stay was 11 days (ranging from 4-22 days). Patients averaged 165 minutes per day (ranging from 140-205 minutes) total of physical therapy, occupational therapy, and speech therapy. Twenty eight of the 30 patients (93%) discharged to the community. One patient required readmission from the inpatient rehabilitation facility to the acute hospital. All 30 patients improved their functional status with inpatient rehabilitation.

Conclusion. In this cohort of 30 patients, inpatient rehabilitation after severe COVID-19 was safe and feasible. Patients were able to participate in frequent, long duration rehabilitation with nearly all patients discharging to the community. Clinically, inpatient rehabilitation should be considered for patients with functional limitations following severe COVID-19. Given 90% of our cohort required critical care, future studies should investigate the efficacy and effectiveness of inpatient rehabilitation following hospitalization for critical illness. Frequent, long duration rehabilitation shows promising potential to address functional impairments following hospitalization for severe COVID-19.

Impact Statement. Inpatient rehabilitation facilities should be considered as a discharge location for hospitalized survivors of COVID-19, especially severe COVID-19, with functional limitations precluding community discharge. Clinicians and administrators should consider inpatient rehabilitation and inpatient rehabilitation facilities to address the rehabilitation needs of COVID-19 and critical illness survivors.

Introduction

Coronavirus Disease 19 (COVID-19) is a rapidly progressing infection caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Complications stemming from COVID-19 can impact the pulmonary, cardiovascular, renal, and neurologic systems potentially leading to multi-organ failure and other sequelae.¹⁻⁹ While 81% of patients have mild symptoms, never warrant hospitalization, and require no oxygen supplementation, approximately 5% will become critically ill requiring intensive care unit (ICU) stays.¹⁰ Often, critically ill COVID-19

patients experience respiratory failure, shock, and/or multi-system organ failure requiring mechanical ventilation and long ICU lengths of stay.¹¹⁻¹⁵ Previous investigations have focused on rehabilitation during acute hospitalization within standard care, physical therapist treatment frequency within the hospital, or rehabilitation within a specialized hospital unit focused on treating COVID-19 patients.¹⁶⁻¹⁸ Patients requiring mechanical ventilation, especially those with acute respiratory distress syndrome, exhibit long term issues across Post Intensive Care Syndrome (PICS) domains for years after ICU discharge.¹⁹⁻²¹

Prior to the COVID-19 pandemic, it was well characterized that critical illness survivors faced significant long-term burdens.²²⁻²³ Survivors often exhibit profound psychological, cognitive, physical, and/or functional issues that are collectively referred to as PICS.²²⁻²⁴ Mechanical ventilation, ICU length of stay, shock, multi-organ failure, immobility, and a host of other clinical and personal factors are associated with more severe issues post critical illness.^{20, 25-27} The acute and long term impairments faced by survivors are significant, and likely require interdisciplinary rehabilitation approaches.^{21, 28-31}

Similar to PICS, patients hospitalized with COVID-19, especially severe disease, may exhibit impairments (eg, muscle weakness), significant activity limitations, and resulting participation restrictions that require ongoing rehabilitation after hospital discharge.³²⁻³⁶ It is likely that many survivors of COVID-19 who required critical care will exhibit significant PICS given that many clinical courses include long lengths of stay, long periods of mechanical ventilation, and multi-organ failure.^{12, 37} How to best rehabilitate survivors with these deficits, and in which setting of care, during the COVID-19 pandemic is yet unclear. Further, issues with physical function, activities of daily living, and cognition ultimately affect the ability of a patient

to discharge to the community, and long term, can decrease quality of life.²⁵ Thus, some patients may require further rehabilitation within the hospital, a sub-acute facility, or an inpatient rehabilitation facility (IRF) before being functionally able to transition to the community. In order to be functionally able to return to the community, a patient must either be independent with household activities of daily living (ADL) and independent with community mobility or have a caregiver able to provide the level of support to the patient to allow for transition to the home and community setting.

In the strain of a pandemic, a rehabilitation program within an IRF for patients recovering from COVID-19 may address patient, pandemic, and system issues by potentially expediting patient recovery, facilitating return to the community, and potentially offloading much needed acute care beds. It is unclear however whether the more frequent and longer duration rehabilitation required to be provided in IRFs (approximately 3 hours per day and at least 900 minutes per week across multiple therapy disciplines) is safe and feasible for patients as well as staff during the COVID-19 pandemic. It is also unclear whether patients can make meaningful gains in functional status and successfully discharge to the community. Therefore, we leveraged a unique retrospective database of patients discharged to an IRF after an acute hospitalization for severe COVID-19 to assess the safety, feasibility, and outcomes of severe COVID-19 survivors who received frequent, long duration interdisciplinary rehabilitation within an IRF directly following hospital discharge.

[H1] Methods

The sample cohort was drawn from 30 consecutive COVID-19 survivors discharged from an acute care hospital into an adjoining IRF between April 2020 and June 2020. Data was extracted

retrospectively post-IRF discharge. This specific IRF normally operates as a standard IRF, but was transitioned to an IRF designed to serve patients recovering from hospitalization for COVID-19 that were medically appropriate for hospital discharge, but were assessed as functionally unable to return to the community safely and successfully. These patients were deemed to be functionally unable to return to the community for a multitude of reasons. For some patients, they live alone and at the time of discharge from acute hospitalization, they were unable to successfully care for themselves from an ADL or mobility standpoint. For other patients, they required more assistance for ADL and mobility than their caregivers are able to provide at time of acute hospitalization discharge.

Demographic data was manually extracted from the electronic medical records including: age, sex, and body mass index. We also extracted total acute hospital length of stay and whether patients ever required critical care. For patients requiring critical care, we extracted ICU length of stay, need for mechanical ventilation (yes vs. no), and the duration of mechanical ventilation.

After acute hospitalization patients were transitioned to the IRF if and when: 1) recommended by acute care therapists- physical therapists, occupational therapists, speech language pathologists, 2) accepted for admission by the physical medicine & rehabilitation service, and 3) deemed medically appropriate for this care transition by the primary medical team. Medical readiness for care transition often revolved around the patient demonstrating consistent and predictable oxygen demands (quantified need for supplemental oxygen in liters per minute) at rest and with activity, even if the 2 were discordant. As is standard in IRFs, patients underwent an individually tailored rehabilitation program delivered by physical

therapists, occupational therapists, and speech language pathologists within the inpatient rehabilitation model of care managed by psychiatrists.

The IRF was physically contained within a large, academic medical center in the Denver Metropolitan Region. Clinically and operationally, the unit was staffed and operated as an IRF with guidance from our local infectious disease and infection prevention teams prior to opening. The IRF was managed by psychiatrists and staffed with rehabilitation nurses. In-patient medicine teams provided consultation on all COVID-19 patients on the IRF to facilitate transition from acute hospital to IRF while ensuring appropriate medical management and assessment following novel infection.

Patients were expected to participate in a minimum of 900 minutes of therapy per week distributed between physical therapists, occupational therapists, and speech language pathologists as defined by admissions criteria guidelines for the Center for Medicare and Medicaid Services (CMS).³⁸ The ultimate goal of IRF admission was to facilitate safe discharge to the community. Therapy sessions ranged from 30 to 105 minutes depending on discipline (physical therapists, occupational therapists, and speech language pathologists) specific needs. Distribution of therapy and length of sessions was determined collaboratively between disciplines based upon an individual patient's presentation, rehabilitation needs, and overall rehabilitation goals. As is common practice in IRFs, rehabilitation plans and specific interventions were based upon patient medical and functional history, current presentation, specific limitations, therapist's evaluations, and interdisciplinary collaboration. A patient's functional history is determined through discussion with patient and/or patient's family/caregiver. This includes if patient was independent or requiring assistance with ADLs or

mobility prior to acute hospitalization. Due to the novel nature of this disease, collaboration between IRF therapists and acute care hospital therapists who were treating COVID-19 patients and/or had expertise in critical illness survivorship was facilitated. Early in the transition from a traditional IRF to an IRF designed to serve patients recovering from hospitalization for COVID-19, meetings and discussions were performed weekly by acute care therapists, IRF therapists, and Physical Medicine and Rehabilitation physicians. The acute care therapists treated COVID-19 patients acutely or possessed experience and expertise regarding rehabilitating patients during and after critical illness. These meetings allowed for interdisciplinary discussion on best practice for rehabilitating patients recovering from severe COVID-19 and critical illness requiring mechanical ventilation.

Outcomes assessed include safety and feasibility of COVID-19 survivors participating in a rehabilitation program within an IRF. Safety outcomes, at both patient and staff level, were defined as rates of patient readmission from the IRF to the acute care hospital and a count of COVID-19 infections among IRF nursing, therapy, and support staff. All our hospital staff, including those on the IRF, were required to fill out a daily attestation form regarding symptoms and possible unprotected exposure to individuals infected with COVID-19. The answers provided could trigger a phone assessment from employee health to determine if the staff member would be allowed to work that day and/or if they required COVID-19 testing. Feasibility outcomes were therapy participation (minutes of therapy as compared to 900 minute/week expectation), and discharge destination to assess whether patients were able to return to the community. Clinical outcomes included functional progress during rehabilitation stay compared to CMS calculated expectations. Functional outcomes were self-care and

mobility scores based on CMS guided Continuity Assessment Record and Evaluation (CARE) tool.^[39] Admission self-care and mobility scores were established collaboratively between therapists and nursing staff. Early after admission to the IRF, expected lengths of stay, self-care scores, and mobility scores were established based on CMS guidelines. These expected outcomes were based on patient diagnosis, admission self-care scores, and admission mobility scores. Functional progress being measured by improvements in self-care and mobility CARE tool scores from admission to discharge at the IRF.³⁹

Ethics approval for this research was granted by the Colorado Multiple Institutional Review Board.

[H2] Role of the Funding Source

None

[H1] Results

Patient demographics are presented in the Table. All patients met the definition of severe COVID-19 infection as outlined by the National Institutes of Health and the World Health Organization.¹⁴ Generally, patients ranged in age from 26 to 80 years, and most were male. The majority required an ICU stay and invasive mechanical ventilation. For patients who required mechanical ventilation, the average length of mechanical ventilation was 18.8 days (range 9-37 days).

Once admitted to the IRF, average length of stay was 12 days (range 4 to 22 days).

Patients averaged 165 total minutes (2.75 hours) of therapy (physical therapists, occupational therapists, and speech language pathologists) per day. This equates to an average of 1,155

minutes (19.25 hours) per week. All 30 patients met the CMS guidelines of completing at least 900 minutes (15 hours) of therapy over the course of a week.

One patient required re-admission back to the acute care hospital, but returned to the IRF within 48 hours. This patient resumed the frequent, long duration rehabilitation program and ultimately discharged to the community. Twenty-eight of the 30 patients (93%) discharged to the community while 2 (7%) discharged to sub-acute rehabilitation facilities. All 30 patients (100%) demonstrated improvements in function as measured by the CMS guidelines for self-care and mobility, and most met their specific goals constructed at admission (Figure).

Patients arriving to the IRF demonstrated average mobility scores of 30.4 (ranging from 17 to 59) out of a possible total of 90 using the CARE tool for mobility. These same patients demonstrated an average self-care score of 21.4 (ranging from 8 to 31) out of a possible total of 42 on the CARE tool for self-care. On admission, scores were established prior to any interventions being provided to the patient. This includes providing a new assistive device or cueing patient. If a patient was deemed unable, or unsafe, to attempt a task prior to intervention, the patient was scored as "not safe to attempt." A score of 60 out of 90 on mobility would equate to the patient being at supervision level with nearly all functional mobility. The average mobility score at admission (30.4) would indicate the patient was requiring maximal assistance for most mobility tasks. A score of 28 of 42 for self-care would indicate supervision level of assistance for self-care tasks. The average self-care score at admission (21.4) would indicate the patient was requiring moderate to maximal assistance for nearly all self-care items. At discharge patients demonstrated an average mobility score of 79.6 (ranging from 48 to 90). They also demonstrated an average self-care score of 39 (ranging from

32 to 42). Twenty five of the 30 patients (83%) met their target self-care score and 26 of the 30 patients (87%) met their target mobility score. By discharge, the average mobility and self-care scores indicated that patients generally required no physical assistance (and at most supervision) for all mobility and ADL tasks including ambulation, dressing, toileting, and stairclimbing.

Within the first 30 days after discharge from the IRF, no patients were readmitted to the 12 hospitals within our state-wide health system. Within 6 months of discharge, 2 of the 30 patients (7%) were admitted to a hospital within our system.

On the IRF, during the transition into a COVID-19 inpatient rehabilitation, and for 3 months following no health care providers on the unit reported symptoms consistent with COVID-19, were assessed as unable to work by employee health, or tested positive for COVID-19.

[H1] Discussion

In this cohort of 30 COVID-19 survivors, most of whom required mechanical ventilation and prolonged ICU stays, post hospital rehabilitation within an IRF was safe, well tolerated, and associated with high rates of functional improvement allowing for community discharge. Patients averaged 2.75 hours (165 minutes) of therapy per day, and 19.75 hours (1,155 minutes) per week, with progression to home or prior living situation in less than 2 weeks. The IRF model of rehabilitation and the duration of rehabilitation provided did not result in significant adverse events for patients or clinicians.

Little data exists on the rehabilitation, and subsequent outcomes, of patients with COVID-19, especially those with severe disease who cannot discharge directly from the hospital to the community.^{16, 32, 35-36}

These data supports the potential safety and feasibility of rehabilitation within an IRF for COVID-19 survivors without significantly modifying standard IRF clinical operations and rehabilitation approaches. To our knowledge, this is the first study on rehabilitation of COVID-19 survivors within an inpatient rehabilitation facility functioning within a standard IRF model of care. Previous investigations have focused mostly on quantifying impairment or rehabilitation during acute hospitalization including the creation of alternate hospital units for rehabilitation^[17-18, 35-36]. Such models and settings may not have the commensurate resources (equipment and staff), duration of rehabilitation (at least 900 minutes a week), and model of interdisciplinary rehabilitation delivery (physical therapists, occupational therapists, and speech language pathologists in an IRF with physiatrists) to facilitate optimal recovery of function that transitions patients back to the community in a time efficient (shortest LOS) and effective manner (low rate of readmissions).

In a larger cohort (100 patients), Piquet et al were able to quantify more specific physical performance measures, subjective reports, and physiologic limitations at admission and discharge via: sit to stand testing, perceived exertion, Barthel ADL index, and grip strength^[18]. However, we provide unique data on minutes of therapy performed, mobility and ADL performance, readmissions, and discharge location. When combined this further supports the safety, feasibility, and need for rehabilitation during and following hospitalization for COVID-19, especially for those requiring critical care. Uniquely, our data suggest the safety and impact of

more frequent (at least 2 visits per day), longer duration (at least 900 minutes a week) rehabilitation within an IRF post hospitalization.

Our cohort and approach are also distinctly different than previous reports.^{17-18, 35-36} Importantly, Piquet et al did not perform the redeployment of an existing IRF and the IRF model of rehabilitation delivery to manage COVID-19 survivors.¹⁸ Rather they created a novel unit within an acute care hospital to deliver rehabilitation for hospitalized COVID-19 patients. Ninety percent of our patients required critical care while only 23% of the patients in the Piquet cohort required an ICU stay. Further, we provided rehabilitation under a standard IRF interdisciplinary model of care which aimed for at least 900 minutes of total therapy per week divided amongst physical therapists, occupational therapists, and speech language pathologists with attending physiatrists, rehabilitation nurses, and interdisciplinary rounds. Piquet et al provided shorter treatment sessions (20 minutes or less) twice daily. Therapy was limited to physical therapists sessions with no OT and speech language pathologists involvement initially. Our IRF provided physical therapists, occupational therapists, and speech language pathologists for over 1,155 minutes per week and 165 minutes per day. This is drastically different than other reports on rehabilitation post COVID-19, and exceeded the CMS IRF guidelines of at least 900 minutes of therapy per week.

Even the severe cases in our cohort who required mechanical ventilation and prolonged ICU stays were able to participate in long duration rehabilitative care without significant complication while demonstrating clinically important functional improvements. Our results suggest the existing model of care within an IRF can be applied to post hospitalization

rehabilitation of select COVID-19 survivors, even those with severe disease requiring mechanical ventilation prior to IRF admission.

While we were not able to definitively quantify readmission rates to any Colorado hospital within 30 days of IRF discharge, we were able to explore if patients were admitted to any of the hospitals within our health system. Our system contains 12 hospitals that surround the Denver Metropolitan area and span the entirety of the state. Of the 2 patients readmitted to our hospital system, neither required this readmission within 30 days. One patient was readmitted 3 months after IRF discharge with tracheal stenosis and one patient was readmitted 5 months after IRF discharge for arteriovenous fistula creation.

Notably, 2 patients (7%) required discharge to a subacute rehabilitation facility suggesting they may not have been ideal candidates for IRF admission. Yet, both of these patients actually demonstrated functional improvements during their stay on the IRF and participated in the required 900 minutes per week of therapy without complication. The 2 patients were able to demonstrate comparable progress with self-care and mobility to the rest of the cohort. We do not find this result unacceptable or overly concerning. Their course was characterized by slower progress than anticipated necessitating a transition to subacute rehabilitation for a longer length of stay in order to progress towards community discharge.

IRFs generally do not achieve a 100% discharge to community rate. Such a goal may result in withholding inpatient rehabilitation in an IRF from patients who may truly benefit, but whose expected functional progress and prognosis for community discharge at time of IRF admission are not yet fully known. As an example, between 2018 and 2020, 8.5% of patients admitted to our IRF discharged to sub-acute rehabilitation or skilled nursing facilities. Based on

the Case Mix Index (CMI) calculation by CMS for this group of patients, it was projected that 7% of these patients would discharge to a sub-acute rehabilitation facility or skilled nursing facility. CMI is a measure that reflects the diversity, complexity, and severity of patient illnesses treated at a given hospital or other healthcare facility.⁴⁰ The CMS estimated length of stay and functional outcome expectations are based on the patient's CMI.

It must be noted that this IRF was not opened or operated in isolation. Historically, it is an IRF that served patients with a high medical acuity including those who survived hospitalization for: solid organ transplant, critical illness, trauma, and left ventricular assist device placement. As evidence, our unit's CMI has steadily increased over the last three years, and per CMS has reached as high as 1.70 twice in 2020. Our IRF is physically contained within a large academic hospital that treated large numbers of COVID-19 patients, especially severe cases. There was significant collaboration and input from in-patient medical teams, infection prevention, and critical care survivorship/rehabilitation therapy experts. Content experts and acute care therapists actively working with COVID-19 patients within the hospital shared clinical knowledge and considerations relating to rehabilitation of COVID-19 and critical illness survivors. Attending physiatrists on the IRF were also actively involved in the acute hospital COVID-19 therapy team and overall hospital operations surrounding COVID-19 patient throughput. We are unsure if a similar approach would work on a non-integrated, less acute IRF. Our experiences suggest re-deploying an existing IRF to serve survivors of severe COVID-19 may require significant collaboration.

Clinicians, therapists specifically, can spend upwards of 90 minutes continuously with patients on the IRF. Despite the close physical contact and significant staff-patient interaction

within the IRF level of care, there were no known adverse effects to staff members. No clinicians on the IRF contracted COVID-19 during, or for the 3 months following, the IRF's redeployment to serve COVID-19 patients. IRF procedures aligned with our system wide infectious disease and infection prevention guidelines. The CDC allows for precautions to be lifted after 20 days of isolation.⁴¹ Of note, 9 of the 30 patients (30%) were over 21 days past initial diagnosis when admitted to the IRF. Despite the CDC recommendation for liberating precautions at 21 days, at the recommendation of our health system's infection prevention team all 30 patients were kept on enhanced precautions consisting of droplet and contact precautions with eye protection during the initial transformation of the IRF to rehabilitate COVID-19 patients.

During and following periods of high COVID-19 hospitalizations, large numbers of patients may be liberated from mechanical ventilation and survive past ICU discharge.³² Given what is known about critical illness survivorship and what has been described in COVID-19 survivors, it is reasonable to continue to expect that survivors of severe COVID-19 are likely: 1) to have significant and severe limitations, 2) present with components of PICS, 3) exhibit long hospital lengths of stay, and 4) require significant rehabilitation.^{11-15,19-24,32-36,42-43} Survivors, and hospitals, face a dually difficult conundrum: patients may not be physically able to discharge to the community and hospitals may not be able to effectively transition patients to other levels of care for rehabilitation. In the midst of a local surge in COVID-19 cases, ICU survivors that require significant rehabilitation can strain hospital system capacity by potentially slowing hospital throughput and limiting abilities to manage further waves of COVID-19 hospitalizations. Patients may be stuck to "rehabilitate in place" within the acute hospital as

hospital systems simultaneously struggle to provide individualized, frequent, long duration rehabilitation and facilitate safe, effective hospital discharge.

Generally, inpatient rehabilitation in an IRF may not always be considered for survivors of critical illness given concerns over patient participation, medical acuity, safety, and unknown effectiveness. Given the majority of our cohort required critical care and mechanical ventilation > 14 days, broader consideration of admission to IRF for patients who survive critical illness and mechanical ventilation seems prudent.

For patients surviving hospitalization for severe COVID-19, rehabilitation within an inpatient rehabilitation facility and model of care was safe, feasible, and well tolerated leading to functional improvement and high rates of community discharge with low rates of hospital readmission.

Our experiences rehabilitating patients who survived severe COVID-19 within an IRF suggests that select COVID-19 patients can benefit from inpatient rehabilitation post hospitalization to facilitate functional improvement and community discharge. The well-developed IRF model of care should be considered by clinicians and administrators for patients who survive hospitalization for COVID-19. Future research and clinical programs should prioritize utilizing IRFs, and the IRF model of rehabilitation delivery, for further investigation of rehabilitation post-hospitalization for survivors of COVID-19 specifically and critical illness generally.

Given the number of COVID-19 hospitalizations during the pandemic, and the growing number of critical illness survivors annually, identifying and studying who may tolerate and

benefit from inpatient rehabilitation in an IRF should become a clinical, research, operational, and policy priority.

[H2] Study Limitations

Our study has important limitations. First, this is a retrospective study of only 30 patients from a single IRF thus limiting any generalizability and specific conclusions on causality. Second, we were only able to assess readmissions to our specific hospital system (12 hospitals), thereby limiting the precision in quantifying actual readmission rate, and possibly under estimating true hospital readmissions. Although we quantified trajectory of independence and the need for assist with mobility and ADL tasks, we lack data on patient medical conditions beyond COVID-19, detailed physical examination findings, and physical performance measures over time.

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Disclosure

The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest.

UNCORRECTED MANUSCRIPT

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Tables

Table: Sample Demographics

Characteristic	N(%) or mean (SD)
Age, years	54.6 (13.2)
Sex, % female	7 (23)
Body Mass Index, kg/m ²	32.3 (9.6)
Hospital Length of Stay, days	27.8 (11.0)
ICU Admission, %	27 (90)
ICU Length of Stay, days	23.1 (9.4)
Mechanically Ventilated, %	25 (83)
Days on mechanical ventilation	18.8 (6.4)
Admission Self-Care Score, points ^a	21.4 (5.5)
Admission Mobility Score, points ^b	30.4 (10.1)

^a Maximum score for Self-Care: 42

^b Maximum score for Mobility: 90

Figure Captions

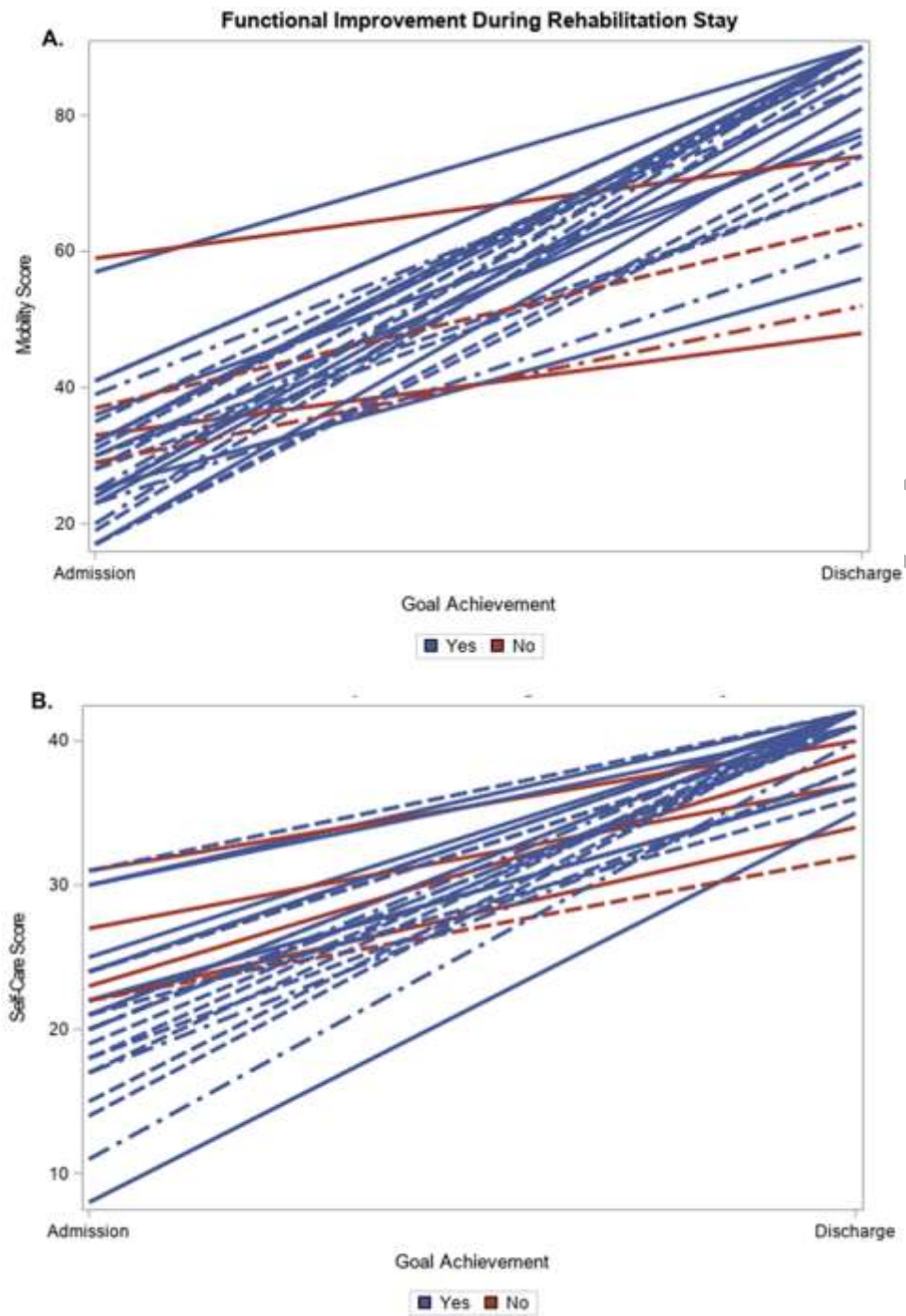


Figure: Functional progress for all 30 individuals in the study sample during their inpatient rehabilitation stay. Panel A shows improvements in mobility scores on the CARE tool for inpatient rehabilitation, and Panel B shows improvements in the self-care scale. Blue lines indicate those who met the functional goals set at admission and red lines indicate those who did not meet functional goals prior to discharge.