



## HSS Beyond: Moving Forward After COVID-19

Danielle Edwards, PT, DPT  · Theresa Chiaia, PT, DPT ·  
Jessica Hettler, PT, DPT, MHA, ATC, SCS, OCS, Cert MDT · Katherine Wilson, PT, DPT ·  
Sharlynn Tuohy, PT, DPT, MBA · Polly de Mille, RN, CEP-ASCM, CSCS

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### Introduction

Hospital for Special Surgery (HSS) Rehabilitation and Performance provides comprehensive rehabilitative, performance, and wellness services to patients with a wide variety of musculoskeletal impairments, across the spectrum of age, from non-surgical to pre- and post-surgical settings. These settings traditionally include inpatient, ambulatory, and outpatient care. The performance team of clinical exercise physiologists provides services ranging from testing and training of high-level athletes to working closely with the rehabilitation team in bridging the gap between physical therapy (PT) and comprehensive fitness training. Most recently, Rehabilitation and Performance implemented care delivery through a virtual platform allowing our team to expand accessibility of our services to patients in the home setting. Composed of a variety of clinicians, including physical therapists, occupational and speech therapists, exercise physiologists, and certified athletic trainers, this dynamic team strives to provide individuals with targeted, high-quality care.

In March 2020, the typical musculoskeletal practice for HSS Rehabilitation and Performance rapidly changed to meet the needs of patients affected by COVID-19. As of March 31, 2020, according to the Institute for Health

Metrics and Evaluation's estimates, New York State had more than 100,000 COVID-19 cases and 1500 deaths [9, 10]. The New York State Commissioner of Health directed all general hospitals, ambulatory surgery centers, office-based surgery practices, and diagnostic and treatment centers to increase the number of beds available to patients, including canceling all elective surgeries and procedures [8]. HSS, primarily an elective surgery institution, assisted New York City by partnering with local hospitals to provide vital medical equipment and personnel for the growing number of patients affected by COVID-19. From March 20, 2020, to May 18, 2020, HSS admitted 286 patients from neighboring hospitals, of which 132 had COVID-19 and 26 required critical care.

During this crisis, HSS Rehabilitation and Performance pivoted from providing musculoskeletal patient care to meeting the urgent needs of patients with COVID-19. A team of acute care and outpatient physical therapists, an exercise physiologist who is also a registered nurse, rehabilitation technicians, administrators, and informaticists worked collaboratively to treat this patient population. This team designed and implemented programs to address the needs of COVID-19 patients across the spectrum of care, including the ICU, acute care, and home care, using a combination of virtual and in-person treatment. Here we describe how the HSS Rehabilitation and Performance team designed and implemented a virtual treatment program with a long-term vision to be initiated after hospital discharge, in the patient's home. This program is called HSS Beyond: Moving Forward After COVID-19.

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D. Edwards, PT, DPT (✉) · T. Chiaia, PT, DPT ·  
J. Hettler, PT, DPT, MHA, ATC, SCS, OCS, Cert MDT ·  
K. Wilson, PT, DPT · S. Tuohy, PT, DPT, MBA ·  
P. de Mille, RN, CEP-ASCM, CSCS  
Hospital for Special Surgery,  
535 East 70th Street,  
New York, NY 10021, USA  
e-mail: edwardsd@hss.edu

### Recognition of COVID-19 Patient Rehabilitation Needs

As HSS began to admit COVID-19 patients in March 2020, knowledge was scarce on the presentation and long-term effects of this novel disease. As a result, HSS Beyond was based on observations related to the musculoskeletal effects of severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and prolonged mechanical

ventilation of ICU patients. Additional information about COVID-19 suggested the possibility of significant musculoskeletal and neurological sequelae following infection including weakness due to cytokines that target and damage musculoskeletal tissues [5]. Prolonged bed rest and serious multisystem illness result in myalgia and arthralgia, which can lead to long-term musculoskeletal consequences, including loss of bone mineral density (BMD) [5].

Although COVID-19 appears to be primarily a respiratory illness, the cardiovascular system is also affected by the loss of expression of angiotensin-converting enzyme 2 (ACE-2), and so cardiovascular impairments should not be ignored. Acute cardiac injury, defined as significant elevation of cardiac troponin levels, is the most commonly reported cardiovascular abnormality in COVID-19, with average incidence of 8–12% [2]. Additionally, central nervous system perfusion may be affected, resulting in impaired autonomic nervous system regulation of blood pressure and respiration [2]. The comprehensive burden of this illness requires careful consideration when planning a safe, comprehensive rehabilitation program. Compared with our typical orthopedic patients, those recovering from COVID-19 were far less hemodynamically stable and therefore required careful vital signs monitoring during treatment sessions provided through our HSS Beyond program.

Building a program to address rehabilitation of patients with COVID-19 precluded a “one size fits all” approach, as they encompass a wide spectrum of ages, co-morbidities, socioeconomic, and health status. As a novel disease, the lack of evidence-based interventions required our team to rely on their clinical expertise and knowledge of other acute respiratory illnesses in designing a program.

HSS Beyond addressed both patients who were extremely debilitated and those who had experienced a less severe course of the illness. An array of interventions aimed at restoring both cardiopulmonary and musculoskeletal function, including flexibility/mobility, endurance, balance, and strength were incorporated into our program. Additionally, the program was designed to require no hospital-based equipment (or minimal to no medical equipment) allowing the patient to continue to progress after discharge home. Avoiding travel to an outpatient physical therapy facility both reduced unnecessary energy expenditure by the patient and reduced the risk of exposure for others. Functional tests and measures were used to provide meaningful information to determine which phase a patient enters at the start of the program and to guide phase progression. An additional focus of HSS Beyond was to gather consistent patient data and outcome measures about patients affected by this illness and their recovery to shed light on the trajectory of recovery following COVID-19.

### **Collaborative Approach**

In developing HSS Beyond, we broadened our ability to manage a multisystem disease and collaborated with physicians and medical researchers to provide effective interventions to the patient throughout their journey. An important focus was to improve a patient’s functional status while

progressively advancing patients to obtain independence, endurance, strength, stability, and overall success beyond COVID-19. The inpatient acute care physical therapists on the front line provided invaluable insight into the functional limitations of these patients and their anticipated outpatient rehab needs. The experience of our outpatient therapists ranges from the frail elderly to an active patient population. The clinical exercise physiologist/RN had experience in both ICU nursing and cardiopulmonary rehab. This wide range of experience provided an advantage when developing a comprehensive program for COVID-19 patients who span the spectrum of age and pre-COVID-19 function. Our rehabilitation technicians, administrators, and informaticists prepared rehab supply kits, created the necessary tools for documentation, and developed data collection protocols to operationalize and execute HSS Beyond.

The combined clinical skill sets provided the basis for robust clinical discussions to identify patient needs and targeted interventions for the appropriate phase of care, while considering both short- and long-term goals. These discussions resulted in the selection of objective tests and measures, as well as interventions designed to progress patients through a phased approach. In addition to resources from the literature and continuing education courses, this team consulted with internal medicine and primary care sports medicine physicians, as well as a Board Certified Cardiopulmonary Clinical Specialist who provided guidance and suggested parameters for our interventions, outcome measures, and criteria for therapy advancement.

### **Program Design and Implementation**

HSS Beyond was designed to be implemented after patient discharge. Patients with COVID-19 require rehabilitation at every level of care, and these needs change depending on their presentation [17]. The acute care physical therapists adapted their approach to provide interventions through in-person and telehealth care (Table 1). To provide continuity of care, HSS Beyond continued interventions initiated in the acute care setting upon the patients’ return home. The acute care therapists were also instrumental in collecting baseline patient information that was used to place patients into HSS Beyond, reducing the initial effort needed from both the patient and the outpatient therapist. Additionally, acute care physical therapists assessed a patient’s need for an appropriate assistive device and identified technology barriers to ensure that the patient could connect with the HSS Beyond team for smoother transition to their homes.

COVID-19 necessitates a new way of life, which includes social distancing and sheltering at home. These factors resulted in HSS Rehabilitation and Performance rapidly shifting to a virtual platform. This platform was not completely new as HSS performs virtual visits for post-surgical patients after total joint arthroplasty in place of traditional homecare services. However, the advent of COVID-19 accelerated the expansion of telehealth services beyond elective joint replacements allowing these services to be offered to both inpatient and outpatients with and without COVID-19. HSS Beyond

**Table 1** Acute care interventions for patients with COVID-19

Phase of inpatient care	Interventions	Mode of delivery
Intensive care unit	Proning/positioning	In-person
	Breathing exercises	In-person
	Chest physical therapy if productive cough	In-person
	Passive range of motion/active assisted range of motion	In-person
Step-down unit	Proning/positioning	In-person
	Breathing exercises	Telehealth/in-person
	Chest physical therapy if productive cough	In-person
	Passive range of motion/active assisted range of motion/active range of motion	In-person
Medical floor	Bed mobility, transfers, ambulation	In-person
	Self-proning	Telehealth
	Breathing exercises	Telehealth
	Therapeutic exercises	Telehealth
	Bed mobility, transfers, ambulation training; stair training	Observed via telehealth with nursing present and completed in-person if skilled intervention required
	*Collection of functional measure	Telehealth or in-person

\*Critical piece to allow for identification of HSS Beyond phase of entry to program

benefited from the acceleration of the virtual platform. Literature has supported the positive benefits of home-based services as these services can reduce cost, maintain quality and safety, and improve patient experience [11].

In designing the outpatient program, we tracked tolerance to exercise using different measures than are typical for our musculoskeletal population. The patient presentation needed to be noted and response to treatment closely monitored with observable metrics and subjective outcomes. During the pre-discharge visit, the acute care rehabilitation team captured baseline patient information with the use of exercises and functional tests and measures, in-person and via inpatient telehealth that would guide HSS Beyond phase assignments and progression. Response to exercise was monitored using the Borg rate of perceived exertion (RPE) scale [4, 6], bilateral thigh girth [1, 7, 18], and oxygen saturation [3]. Functional performance was quantified using pedometer, timed up and go (TUG) [6], five times sit to stand [13], single leg stance (SLS) [16], 2-min walk test [4], and 6-min walk test. Patient-reported outcomes were collected via SF-36 [6, 12] and the Self-Assessment Numeric Evaluation (SANE) [15]. To allow the patient to monitor essential vital signs while participating in therapy session including collection of functional tests and measures upon discharge, each patient was provided with a rehab supply kit that included: pulse oximeter, pedometer, pre-measured 3-m twine, resistance bands, straws, and a tape measure.

HSS Beyond met the needs of patients at a range of functional levels. The program was divided into 4 progressive phases (Table 2). Patients would enter into a HSS Beyond phase based on their rehabilitation and medical needs at the time of discharge. Monitoring oxygen saturation, general functional movement, increased walking stamina, and ability to progress strengthening exercises with resistance and body weight loading were factored into the criteria for progression. Each phase included goals and general guidelines regarding monitoring oxygen saturation, perceived exertion using the Borg scale, and red flags for when

to discontinue exercise or seek medical attention. Each phase included breathing exercises as well as exercises to progress strength, balance, mobility, and cardiorespiratory capacity. In order to progress to the next stage, the patient must have demonstrated the ability to perform all the exercises while maintaining an oxygen saturation >94% at rest and >90% during exercise, an RPE ≤ 4 during exercise, and to complete all repetitions of the entire program with good form.

It was crucial for HSS Beyond to begin immediately after discharge to ensure a successful transition to home as the rehabilitation and performance team recognized that patients were being discharged home with significant musculoskeletal and cardiopulmonary impairments that would need to be addressed. Telehealth ensured continuity of care services upon discharge. Levine et al. suggested that the goal should be “the right care to the right patient at the right time in the right place” as they explored virtual health care for 24-h physician and nursing services, allowing for around-the-clock connectivity through texting, video, and virtual consult [11]. Virtual health care allowed care to be given in a patient-centered manner [11]. HSS Beyond is a patient-centered program. It provided the right care through a phased approach, to the right patient, determined by evaluation upon discharge. Care was provided at the right time, immediately following discharge and importantly, in the right place—their homes.

The pandemic has presented the need to re-conceptualize clinical practice in delivery of rehabilitation services. The tests and measures including in HSS Beyond met the best criteria to assess the functional capabilities of this new patient population via telehealth. The ability to capture outcome measures and deliver treatment guidelines virtually was a major shift in our standard practice. A rehabilitation clinician typically gathers information through touch. In the current state, we have learned to adapt our practice to rely on our eyes and ears for the ability to assess our patients. Although in-person visits have advantages, we have found that we can deliver via telehealth high-quality care to

**Table 2** HSS Beyond: phases of post-discharge intervention for patients with COVID-19

	Phase 1: start to move	Phase 2: build strength	Phase 3: address impairments	Phase 4: return to function
Goals	Activate muscles Develop flexibility Initiate movement	Challenge muscles Increase step count Increase stamina Develop flexibility Track step count to monitor progress Avoid fatigue with daily exercise Avoid pain with exercise Avoid one strenuous exercise session: perform several short exercise sessions per day	Develop muscle strength Develop flexibility Increase stamina Increase step count Increase walking distance Track step count to monitor progress Exercise daily	Develop muscle strength Develop flexibility Return to pre-COVID-19 function Increase step count Track step count to monitor progress Exercise daily
General recommendations and precautions	Track step count to monitor progress Avoid fatigue with daily exercise Avoid pain with exercise	Feel invigorated after exercise Avoid fatigue with exercise Avoid pain with exercise Avoid one strenuous exercise session: perform several short exercise sessions per day 6–min walking test	Feel invigorated after exercise Avoid fatigue with exercise Avoid pain with exercise	Feel invigorated after exercise Avoid fatigue with exercise Avoid pain with exercise
Criteria for Advancement Interventions positioning	Timed up and go Prone lying [14] supine thoracic extension Active breathing for dry cough: Pursed lip Straw Diaphragmatic ACBT for productive cough: Breathing control Deep breaths Huffs Coughs <i>-Not appropriate at this time</i>	Any positions relevant for this phase? Active breathing for dry cough: Pursed lip Straw Diaphragmatic ACBT for productive cough: Breathing control Deep breaths Huffs Coughs Weight shift	Any positions relevant for this phase? Active breathing for dry cough: Pursed lip Straw Diaphragmatic ACBT for productive cough: Breathing control Deep breaths Huffs Coughs	Any positions relevant for this phase? Active breathing for dry cough: Pursed lip Straw Diaphragmatic ACBT for productive cough: Breathing control Deep breaths Huffs Coughs
Breathing exercises				
Balance		Single leg stance with head turn	Single leg stance with opposite hip movements	Single leg stance with opposite hip movements

<p>Single leg stance with arm support March in place with arm support Cat/cow quadruped rocking back Quadruped rocking forward Calf stretch (stand) Hamstring stretch (stand) Upper body Scapular punch Biceps curls Scapular retraction with bands Shoulder extension with bands Lower body Prone hip extension Sitting knee extension bridge Bent knee fall out Ankle plantarflexion with band</p>	<p>Scapular retraction, heel slides Shoulder flexion Knee to chest Calf stretch (stand) Isometric abdominal bracing gluteal sets quadriceps sets</p>	<p>Address flexibility impairments Address flexibility impairments Upper body and trunk Arm reach on hands and knees Wall pushup Triceps extension Scaption Lower Body and Core Bridge with weight shift Chair squats Side-lying release Clam shell Calf raises</p>	<p>Address flexibility impairments Advances lower body and core Bird dog Bridge with March forward step up Side-stepping Single leg chair squat with opposite foot support</p>	<p>March in place Arm swings Side steps Boxing Arm circles</p>
<p>Basic movements Stretching Strengthening exercise Interval Training</p>				

ACBT, active cycle of breathing techniques

patients recovering from COVID-19 and engage more patients in rehabilitation who may otherwise have been limited geographically.

## Discussion

The anticipated consequences or sequelae of COVID-19 warranted swift intervention by rehabilitation services. Although the role of a rehabilitation department in a specialty musculoskeletal hospital during a medical crisis might not seem obvious, the expansive scope of expertise in our multidisciplinary team provided a unique lens through which to understand the rehabilitation needs of patients with COVID-19. Our first priority was to develop a population-specific plan of care deliverable via telehealth, a goal complicated by limited knowledge of the illness trajectory.

The diversity of experience and expertise of the various clinicians allowed for the rapid development of a comprehensive rehabilitation plan as our collaborative teams worked in concert to address treatment needs of patients with COVID-19, in both the inpatient and the outpatient settings. Tests and measures were implemented to guide progression of patients through each phase of the outpatient program. Since our clinicians identified valid and reliable tools, we effectively set a foundation for research to inform future rehabilitation programs. As the sequelae of COVID-19 exist in our society and the potential for resurgence is real, the information collected will provide clinical pearls that will transform our future practice.

## Compliance with Ethical Standards

**Conflict of Interest:** Danielle Edwards, PT, DPT; Theresa Chiaia, PT, DPT; Jessica Hettler, PT, DPT, MHA, ATC, SCS, OCS, Cert MDT; Katherine Wilson, PT, DPT; Sharlynn Tuohy, PT, DPT, MBA; and Polly de Mille, RN, CEP-ASCM, CSCS, declare that they have no conflicts of interest.

**Human/Animal Rights:** N/A

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