HSS Beyond: Moving Forward After COVID-19

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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.

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     | Prone/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         | Prone/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 | In-person     |
|                        | Bed mobility, transfers, ambulation | In-person     |
| Medical floor           | Self-proneing | 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 |

*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 outcomes and deliver treatment guidelines virtually was a major shift in our standard practice. A rehabilitation clinician typically gathers information though 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
| Phase 1: start to move | Phase 2: build strength | Phase 3: address impairments | Phase 4: return to function |
|-----------------------|-------------------------|-----------------------------|-----------------------------|
| Goals | Activate muscles | Challenge muscles | Develop muscle strength |
| | Develop flexibility | Increase step count | Develop flexibility |
| | Initiate movement | Increase stamina | Increase step count |
| | | Develop flexibility | Increase walking distance |
| General recommendations and precautions | Track step count to monitor progress | Track step count to monitor progress | Exercise daily |
| | Avoid fatigue with daily exercise | Avoid fatigue with daily exercise | Feel invigorated after exercise |
| | Avoid pain with exercise | Avoid pain with exercise | Avoid fatigue with exercise |
| | | Avoid one strenuous exercise session: perform several short exercise sessions per day | Avoid pain with exercise |
| | | | Avoid one strenuous exercise session: perform several short exercise sessions per day |
| | | | Avoid fatigue with exercise |
| Criteria for Advancement | Timed up and go 6-min walking test | Any positions relevant for this phase? | Any positions relevant for this phase? |
| Interventions positioning | Prone lying [14] supine thoracic extension | Any positions relevant for this phase? | Any positions relevant for this phase? |
| Breathing exercises | Active breathing for dry cough: Pursed lip Straw Diaphragmatic ACBT for productive cough: Breathing control Deep breaths Huff Coughs | Active breathing for dry cough: Straw Diaphragmatic ACBT for productive cough: Breathing control Deep breaths Huff Coughs | Active breathing for dry cough: Straw Diaphragmatic ACBT for productive cough: Breathing control Deep breaths Huff Coughs |
| Balance | -Not appropriate at this time | Weight shift | Single leg stance with head turn |
| | | | Single leg stance with opposite hip movements |
| Basic movements | Single leg stance with arm support | March in place with arm support | Cat/cow quadruped rocking back | Quadruped rocking forward |
|-----------------|-----------------------------------|---------------------------------|-------------------------------|-----------------------------|
|                  |                                   |                                 |                               |                             |
| Stretching       | Shoulder flexion                  | Calf stretch (stand)            | Hamstring stretch (stand)     | Address flexibility impairments |
|                  | Knee to chest                     | Calf stretch (stand)            |                               | Address flexibility impairments |
|                  | Calf stretch (stand)              | Upper body                     | Scapular punch                | Upper body and trunk        |
| Strengthening    | Isometric abdominal bracing      | Biceps curls                   | Scapular retraction with bands| Arm reach on hands and knees|
| exercise         | gluteal sets                     | Scapular retraction with bands  | Shoulder extension with bands  | Wall pushup                |
|                  |                                   | Lower body                     | Prone hip extension           | Triceps extension           |
|                  |                                   | Sitting knee extension bridge   | Bent knee fall out            | Scaption                   |
|                  |                                   | Ankle plantarflexion with band  |                               | Lower Body and Core         |
|                  |                                   |                                 |                               | Bridge with weight          |
|                  |                                   |                                 |                               | shift Chair squats          |
|                  |                                   |                                 |                               | Side-lying release          |
|                  |                                   |                                 |                               | Clam shell                  |
|                  |                                   |                                 |                               | Calf raises                 |
| Interval Training| March in place                    | Arm swings                      | Side steps                    | March in place              |
|                  | Arm swings                        | Side steps                      | Boxing                        | Arm circles                 |
|                  | Side steps                        | Boxing                          |                              |                             |
|                  | Boxing                            | Arm circles                     |                              |                             |

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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