

Post-COVID Care Center to Address Rehabilitation Needs in COVID-19 Survivors: A Model of Care

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Abstract

The severe acute respiratory syndrome coronavirus 2019 pandemic surge left a large cohort of patients vulnerable to cardiopulmonary, neurological, and psychiatric complications. This post-COVID Care center was established to identify patients with disease sequelae and deliver early multidisciplinary rehabilitation services. The evaluation included comprehensive history and physicals, screening tests, labs, and imaging to determine appropriate specialist referrals. After a 6-month period, 278 unique referrals were made to address symptoms reported by 114 patients in specialties including pulmonology, cardiology, and psychiatry. This framework allowed for individualized patient treatment and monitoring of disease after the acute phase of infection. This study highlights the substantial physical and psychosocial impact a coronavirus disease 2019 infection has on patients' long-term trajectory and emphasizes the need for early targeted rehabilitation Post-COVID Care centers. As the world transitions into the chronic phase of this pandemic, this model of care will provide a framework to improve the quality of health care delivery.

Keywords

COVID-19, model of care, rehabilitation

Introduction

The Centers for Disease Control and Prevention estimates that 4%–11% of all individuals with coronavirus disease 2019 (COVID-19) infection will require an intensive care unit (ICU) admission that may include pulmonary support and artificial ventilation.¹ Another 15% will require acute hospitalization and supportive pulmonary care.¹ A distinctive feature of COVID-19 infection is that acute intensive care and ventilator reliance are required for a considerably longer period than most typical ICU admissions, setting the stage for long-term disease sequelae.^{2–4} It is projected that long-term pulmonary dysfunction may be seen in up to 40% of COVID-19 survivors that required ventilatory support. Additionally, neuromuscular weakness and impairments occur in up to 50% of all individuals who have prolonged ICU stays.

Very little has been studied or published regarding the rehabilitation needs of patients with COVID-19 after discharge from acute care. There is an urgent need for a coordinated response to the anticipated cohort of post-ICU patients that the COVID-19 pandemic will create across the United States, as well as globally. The size of this cohort will be unprecedented as the disease surge will yield a very large number of patients vulnerable to long-term neurological, cardiopulmonary, and psychiatric sequelae of a COVID-19 infection. In addition, many of these patients are elderly with additional comorbidities that will require specialized care. There is strong evidence from systematic reviews that early targeted application of rehabilitation interventions is of primary importance to deal with the consequences of intensive care and mechanical ventilation morbidity.^{5–8} This has also been supported by evidence from several randomized controlled trials.^{9–12} Therefore, it is necessary that health care systems mobilize resources to create care centers staffed by multiprofessional teams who are equipped and experienced in providing the necessary interventions dedicated to managing patients with COVID-19 sequelae.

In response to this forecasted national need, Richmond University Medical Center (RUMC) created a novel multidisciplinary Post-COVID Care Center (PCC Center). The PCC Center opened in June of 2020 and provides after-care for the patients

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American Journal of Medical Quality 2022, Vol. 37(3) 266–271

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DOI: 10.1097/JMQ.000000000000014

who underwent a medical admission or treatment for COVID-19. The mission of the PCC Center is to identify patients with COVID-19 disease sequelae and deliver early multidisciplinary rehabilitation services after hospital discharge to improve patient outcomes. The model of care was centered with hospital-affiliated internists performing the initial screening and evaluation of patients during their first visit. This is followed by targeted referral and collaboration to multidisciplinary subspecialty physicians within the hospital facility. The physicians at the PCC Center continue to coordinate their multidisciplinary care and perform follow-up evaluation at subsequent visits. The PCC Center provides a large longitudinal cohort of convalescent patients to prospectively identify the incidence, prevalence, and persistence of pulmonary and extrapulmonary complications associated with a COVID-19 infection.

Methods

Institution Overview and Setting

Data acquisition for this study was approved by the Institutional Review Board (Protocol No. 14346) and informed verbal consent was approved and obtained according to protocol. The study was carried out at RUMC's PCC Center from June 1, 2020, to December 1, 2020. The institution is a 470+ bed health care facility and 1 of 2 acute care facilities that serve nearly 500 000 residents of Staten Island, New York. The institution is located on the North Shore of Staten Island, home to an ethnically diverse population (29.1% Hispanic, 22.5% Black) in which 23.7% of residents are foreign born. A portion of the Primary Service Area served by RUMC contains zip codes with the lowest socioeconomic status, highest concentration of population, highest minority population, and highest immigrant population within the 5 boroughs of New York City. Moreover, Northern Staten Island caters to 4 zip codes classified as Medically Underserved Areas by the US Federal Government.

PCC Center Structure

Anticipating the long-term sequelae of COVID-19, the PCC Center was designed to provide screening for disease outcomes, early rehabilitation, and targeted specialist referrals. Participants were recruited after discharge from hospital, emergency room, local primary care facilities, or self-referral. Inclusion criteria is any adult over the age of 18 who underwent an acute COVID-19 infection. Initial screening was

carried out by hospital-affiliated internists and family medicine physicians. The multidisciplinary subspecialty team included: cardiology, pulmonary, nephrology, neurology, psychiatry, gastroenterology, otolaryngology, sleep medicine, infection control, pharmacy, and radiology specialists.

Primary Visit to PCC Center

The initial visit to the PCC Center included assessment by ancillary staff and vital signs to assess current symptoms and functional status. Patients were then seen by an internist or family medicine physician who gathered in-depth patient histories. Information collected included date of positive COVID-19 test, duration and symptoms of initial viral episode, presence of residual symptoms, inpatient management, use of ventilation, outpatient treatment, and functional status. Physical exams focused on general assessment, cardiac, respiratory, abdomen, and musculoskeletal findings. Lab work and serology included complete blood counts with differentials, complete metabolic panel, ferritin, C-reactive protein, procalcitonin, D-dimer, COVID-19 antibody, and urinalysis. This comprised the baseline evaluation of patients recovering from COVID-19. Any additional labs or testing were completed on a case-by-case basis. Respiratory complaints, if present, were further evaluated using spirometry, pulmonary function tests, chest radiograph, or chest computed tomography (CT) scan. Cardiac complaints were further evaluated with electrocardiography testing, chest radiograph, and chest CT. Any indications of mood changes were further evaluated using Patient Health Questionnaire-9¹³ and General Anxiety Disorder-7¹⁴ tools to assess for psychiatric conditions.

Follow-Up

Patients who screened positive for any assessment were referred to specialists within the institution and received individualized treatment plans. These specialists conducted system-specific history and physicals, reviewed data from initial visits, ordered additional testing or imaging if needed.

Follow-up appointments at the PCC Center were also scheduled to reevaluate patients ideally 1 month after initial evaluation by the PCC team. Patients who required prolonged monitoring were seen periodically at 2, 3, and 6 months. Services provided at each follow-up comprised of a full history and physical to address new or ongoing symptoms and offer referrals when appropriate. Specialists scheduled follow-ups for their evaluations, individualized based on severity

of disease. Patients who no longer required long-term monitoring of their health were returned to their Primary Care Physician or established primary care with Family practice at RUMC. At the time of discharge, the multidisciplinary team provided specific recommendations to the Primary Care Physician to ease transition of care. The timing of this decision was individualized based on patient conditions.

Results

As of December 1, 2020, RUMC has completed 20 633 COVID-19 tests with 1511 positive results. Of those tested positive, 855 patients were admitted to inpatient hospital service for various admitting diagnoses including pneumonia, hypoxemia, altered mental status, and respiratory failure. Of these patients, 135 (15.2%) were admitted to the ICU. The mean length of stay of patients admitted for COVID-19 was 11 days (range, 1–58 d). Over a 9-month period, 599 (67.7%) patients were discharged and 286 (32.3%) patients have expired.

Over the initial 6 months, 114 COVID-19 survivors have presented to the PCC Center for their initial evaluation. The majority of the patients were of Caucasian (n = 46, 40.4%), Hispanic (n = 36, 31.6%), or Black (n = 24, 21.1%) descent. The mean age at presentation was 53 years (range, 21–89 y) and comprised of 66.7% females (n = 76) and 33.3% males (n = 38). After the initial visit, 34 patients have followed-up only once, 20 have followed up twice, 7 have followed up 3 times, 1 has followed up 4 times, and 1 has followed up 5 times. The clinic continues to evaluate an average of 3–4 new patients per week. Residual dyspnea (n = 64, 56.1%), fatigue (n = 52, 45.6%), and mood changes (n = 27, 23.7%) were the

most common symptoms reported symptoms upon initial evaluation to the PCC. Abnormal initial screening and imaging in patients included chest radiograph (n = 8, 7.0%), chest CT scan (n = 3, 2.6%), electrocardiography (n = 4, 3.5%), and echocardiogram (n = 2, 1.8%). Elevated C-reactive protein (n = 31, 27.2%), microalbumin to creatinine ratio (n = 10, 8.8%), complement C3 (n = 9, 7.9%) and C4 (n = 7, 6.1%) lab values were among the most common abnormal lab values.

A total of 278 unique subspecialty referrals were made. Of these, more than half of the patients required further evaluation with pulmonology (n = 88, 77.2%) and cardiology (n = 84, 73.7%). It was anticipated that these services would be the most utilized services among patients based on the nature of COVID-19 infections. Other commonly utilized services included psychiatry (n = 22, 19.3%), otolaryngology (n = 18, 15.8%), gastroenterology (n = 9, 7.9%), and sleep medicine (n = 15, 13.2%), neurology (n = 9, 7.9%), physical therapy rehab (n = 7, 6.1%), nephrology (n = 6, 5.3%), cardiopulmonary rehab (n = 4, 3.5%), hematology (n = 4, 3.5%), occupational therapy (n = 3, 2.6%), vascular (n = 2, 1.8%), dental (n = 1, 0.9%), ophthalmology (n = 1, 0.9%), speech therapy (n = 1, 0.9%), orthopedics (n = 1, 0.9%), allergy (n = 1, 0.9%), immunology (n = 1, 0.9%), and nutrition (n = 1, 0.9%). Persistence of anosmia and ageusia after resolution of the COVID-19 infection, resulted in further evaluation by otolaryngologists. Overweight patients with preexisting obstructive sleep apnea (OSA) presented with exacerbation of their disease and resulted in sleep medicine referrals. Below is a summary table of referral utilization in the patient cohort (Table).

Table. Referral Utilization at the Post-COVID Care Center

Patient Demographic Factors	Pulmonology, n = 88	Cardiology, n = 84	Psychiatry, n = 22	Otolaryngology, n = 18	Gastroenterology, n = 9	Sleep Medicine, n = 15
Age						
Mean	54	54	50	51	44	51
Range	23–89	23–89	26–76	21–75	26–55	26–76
Gender, n (%)						
Male	32 (36)	29 (35)	10 (45)	3 (17)	3 (33)	5 (33)
Female	56 (64)	55 (65)	12 (55)	15 (83)	6 (67)	10 (67)
Body mass index						
Mean	32	32	32	29	31	32
Range	16–70	16–70	16–40	17–40	20–43	24–49
Inpatient admission, n (%)	36 (41)	38 (45)	9 (41)	9 (50)	5 (56)	3 (20)
Length of stay (d)						
Mean	12	12	10	22	13	4
Range	1–65	1–65	3–35	1–38	1–30	1–7
ICU admission, n (%)	4 (6)	3 (4)	1 (5)	1 (6)	0 (0)	0 (0)
Mechanical ventilation, n (%)	12 (14)	11 (13)	3 (14)	3 (17)	0 (0)	0 (0)
Preexisting hypertension, n (%)	31 (35)	31 (37)	5 (23)	5 (28)	0 (0)	7 (47)
Preexisting pulmonary disease, n (%)	21 (24)	20 (24)	6 (27)	0 (0)	1 (11)	5 (33)

Abbreviations: COVID, coronavirus disease; ICU, intensive care unit.

It was evident that COVID-19 had a substantial psychosocial impact on the patient population regardless of demographics or socioeconomic status. This was reflected in mood changes being the third most common complaint expressed by patients. When presenting with depressed mood, hopelessness, anxiety, and/or fatigue, patients were prompted to complete both a Patient Health Questionnaire-9 ($n = 32$) and/or General Anxiety Disorder-7 ($n = 21$) survey. Respectively, these screens were 21.9% ($n = 7$) and 23.8% ($n = 5$) positive in this select patient group prompting referral to psychiatry for support and treatment.

Discussion

Given the rapid progression of the COVID-19 pandemic, health care systems and clinicians need to adapt quickly in order to minimize disease morbidity and psychiatric impact.¹⁵ There is limited knowledge of the long-term sequelae that patients will endure. The creation of multidisciplinary PCC centers to treat both residual symptoms and potential long-term sequelae is necessary to address the after-shock of the acute phase of the COVID-19 pandemic. The cohort described provides direction for research that will aid in understanding the long-term trajectory of COVID-19.

Pulmonary

Pulmonary dysfunction may be seen in up to 40% of individuals who have acute respiratory disorders resulting in the need for mechanical ventilation. For individuals who require artificial ventilation for greater than 48 hours, 65% will have functional impairment after 1 year.¹⁶ COVID-19 contributes to the need for ICU admission and increases the likelihood of developing respiratory sequelae.¹⁷ It is predicted that pulmonary impairment may be present in 11%–45% of coronavirus survivors after 12 months.¹⁷ Available studies of COVID-19 survivors suggest a spectrum of persistent respiratory dysfunction. Residual dyspnea was found to be the most common chief complaint at the PCC Center. Additionally, out of the 262 referrals made to subspecialists, the most frequently utilized service was pulmonology, encompassing almost one third of all referrals ($n = 88$). Of these patients, approximately 41% needed inpatient hospitalization for their acute COVID-19 infection and only 14% required mechanical ventilation (Table). Interestingly, most were healthy without preexisting hypertension or pulmonary disease prior to the COVID-19 infection (Table).

Patients with COVID-19 may benefit from early stage pulmonary rehabilitation intervention in order to improve outcomes.¹⁸ An Italian randomized controlled clinical trial evaluated the effect of respiratory rehabilitation on 72 elderly patients with COVID-19. It found that pulmonary rehabilitation resulted in significant improvement of respiratory function, endurance, quality of life, and depression.¹⁹ Pulmonary rehabilitation intervention not only improves physical and mental conditions but also helps the patient to return to work and society.²⁰ This framework of health care delivery allows clinicians to provide surveillance for patients needing pulmonary rehabilitation. Referrals made by PCC Centers can monitor important prognostic factors for pulmonary function using spirometry testing and severity index tools like the 6-minute walk test to longitudinally gauge functionality.²¹ Thus, screening patients for pulmonary impairment and implementing early-stage pulmonary rehabilitation is essential in management of patients with pulmonary sequelae at the PCC Center.

Cardiology

Although clinical manifestations of COVID-19 are mainly respiratory, infected patients may also experience cardiac injury. Presentation can include arrhythmia, cardiac insufficiency, ejection fraction decline, troponin-I elevation, persistent tachycardia, and severe myocarditis with reduced systolic function.^{22,23} In 1 cohort study of 416 patients with COVID-19 in Wuhan, China, 20% of patients developed cardiac injury. These patients were more likely to have comorbidities, require mechanical ventilation, develop other complications (acute respiratory distress syndrome, acute kidney failure, electrolyte disturbances, hypoproteinemia), and have higher mortality rate.²⁴ In another recent report of 138 hospitalized COVID-19 patients, 16.7% of patients developed arrhythmia and 7.2% experienced acute cardiac injury.²⁵

There is very little known about long-term cardiac complications among patients with COVID-19.²⁶ From the patients referred to cardiology ($n = 84$) at the PCC Center, the majority were middle-aged (mean of 54, range 23–89) females (Table). Approximately one third had preexisting hypertension ($n = 31$, 37%) (Table). However, young and healthy adults also developed cardiac injury that warranted cardiology referral. These patients complained of new-onset palpitations, hypertension, and/or dyspnea. The data confirm the uncertainty of the long-term effects these patients. There are multiple factors that may have influenced cardiac injury including hospitalization,

demographics, autoimmune reactions, and direct injury by viral infiltration.²⁵ The introduction of Post Covid are centers can aid in identify patients requiring additional cardiac rehabilitation and streamline them to specialist care. Cardiac specialists identify and treat sequelae of infection with focused care and testing. For patients referred, staff longitudinally monitor left ventricular ejection fraction with echocardiography and functional status with Cardiopulmonary Exercise Testing.

Psychiatric and Psychosocial

Patients with COVID-19 have an elevated risk of developing psychiatric complications and reduction in quality of life in the long term.²⁶ The cohort at the PCC highlighted the need for appropriate screening for psychiatric illnesses and early intervention, as mood changes were the third most reported complaint, occurring in 23% (n = 27) of patients. Providers found that preexisting psychiatric illnesses were heightened due to the COVID-19 pandemic, making management and treatment difficult. Many patients presented to follow-up earlier than scheduled due to anxiety over residual symptoms and long-term sequelae of their infection. Due to the crucial and deleterious effects on mental health, evaluation at a PCC Center should include a more inclusive and comprehensive psychiatric evaluation on every patient in order to fully expand on this topic. Approximately 60% of patients requiring psychiatric referrals at the PCC Center did not undergo an inpatient hospitalization, thus highlighting the acute deterioration in mental health that may occur while in quarantine and social isolation.

Other Referrals

Other subspecialty services utilized were Otolaryngology (n = 18), Sleep Medicine (n = 15), and Gastroenterology (n = 9). The most common reason for an Otolaryngology referral was persistence of anosmia and ageusia after resolution of the COVID-19 infection. Interestingly, a number of patients required sleep medicine referrals. It has been reported that patients with OSA experienced approximately 8-fold greater risk for COVID-19 infection compared with a similar age population.²⁷ Additionally, OSA has been associated with increased risk of hospitalization and approximately double the risk of developing respiratory failure. However, little is known about needs of patients with OSA after resolution of acute COVID-19

symptoms.²⁷ Overweight patients with preexisting OSA were found to present with exacerbation of their disease, even in the absence of ICU admission or mechanical ventilation (Table). In regard to patients referred to gastroenterology, complaints included nonspecific epigastric pain (n = 3, 33.3%), which began shortly after infection with COVID-19 with no history of gastroesophageal reflux disease or imaging findings suggesting esophagitis. Additionally, young and healthy adults with no history of alcohol use or preexisting liver disease were also referred due to abnormal liver function tests (n = 3, 33.3%) after complaining of intermittent abdominal pain or abnormal bowel movements. These patients had elevations in alanine aminotransferase (n = 2, 22.2%), aspartate aminotransferase (n = 2, 22.2%), alkaline phosphatase (n = 2, 22.2%), and total bilirubin (n = 1, 11.1%). The PCC Center continues to monitor these patients longitudinally for symptom severity and resolution.

Strengths of this study include presenting prospective data from a large diverse cohort of COVID-19 survivors. Although this is a single-center descriptive study, it provides a care model for how other hospital organizations and health systems can establish their own PCC centers. Additionally, rather than having predetermined management, referral, and follow-up protocols, our health care provides could individualize care for each patient based on symptom severity and clinical findings. Although this may seem a weakness, it allows for increased generalizability for the data to standard clinical practice.

Conclusions

The COVID-19 pandemic has posed unprecedented challenges on health care systems globally and yielded catastrophic death tolls. Most of the efforts have revolved around the acute phase of the infection, however, health care professionals must shift gears to managing the long-term sequelae of COVID-19 survivors. Being able to care for these patients in a single facility dedicated to address their unique needs has been an overall success. Established and coordinated multidisciplinary postdischarge responses at the PCC Center has allowed for identification of patients that require subspecialty referral and targeted interventions. The reported experience can potentially help guide health officials develop effective postdischarge care centers for management of this disease, as well as direct further prospective studies looking at specific therapies, rehabilitation, and screening services to improve patient outcomes.

Acknowledgments

The authors would like to acknowledge the following students who contributed to data collection and editing of this article. Noelle Byrne, MD; Samadhi Liyanage, MD; Christine Rizkalla, MD.

Conflicts of Interest

The authors have no conflicts of interest to disclose.

Disclaimer

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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