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The Johns Hopkins Post-Acute COVID-19 Team (PACT): A Multidisciplinary, Collaborative, Ambulatory Framework Supporting COVID-19 Survivors

Emily Brigham, MD, MHS,^a Jacqueline O'Toole, DO, MHS,^a Soo Yeon Kim, MD,^b Michael Friedman, PT, MBA,^b Laura Daly, BSN, RN,^a Adam Kaplin, MD, PhD,^c Meghan Swarthout, PharmD, MBA,^d Brian Hasselfeld, MD,^{e,f} Melissa Lantz-Garnish, RN, BSN,^g Tracy Vannorsdall, PhD,^c Anna Agranovich, PhD,^b Sarath Raju, MD, MPH,^a Ann Parker, MD, PhD^{a,h}

^aDepartment of Medicine, Division of Pulmonary and Critical Care Medicine; ^bDepartment of Physical Medicine and Rehabilitation; ^cDepartment of Psychiatry and Behavioral Sciences, Department of Neurology, Johns Hopkins University School of Medicine, Baltimore, Md; ^dAmbulatory and Care Transitions Pharmacy, Johns Hopkins Health System, Baltimore, Md; ^eOffice of Johns Hopkins Physicians, Johns Hopkins Medicine, Baltimore, Md; ^fDepartment of Medicine, Division of General Internal Medicine, Department of Pediatrics, Division of General Pediatrics, Division of Health Sciences Informatics, Johns Hopkins University School of Medicine, Baltimore, Md; ^gJohns Hopkins Homecare Group, Inc., Baltimore, Md; ^hOutcomes After Critical Illness and Surgery (OACIS) Research Group, Johns Hopkins University School of Medicine, Baltimore, Md.

INTRODUCTION

The Coronavirus Disease 2019 (COVID-19) pandemic has rapidly shifted health care needs and delivery internationally, with about 1 in 5 people with COVID-19 requiring hospitalization, including in the intensive care unit (ICU), at pandemic onset.¹ ICU survivors in general are at risk for impairments in mental, cognitive, and physical health, collectively known as post-intensive care syndrome;^{2,3} similar

challenges have been described post acute hospitalization (post-hospital syndrome).⁴ Risks may be higher among COVID-19 survivors.² Given recognized acute pulmonary complications associated with COVID-19, pulmonary sequelae are a prominent concern,⁵⁻⁷ although COVID-19 has demonstrated an ability to impact multiple organ systems.⁸ Further, emerging scientific data describe a potential for lingering symptoms post-COVID-19 infection even among those who do not require hospitalization.^{9,10} The etiology and physiologic correlates of potential persistent symptoms require sufficient resource infrastructure for comprehensive supportive care and further insight into the natural history of COVID-19.

We provide a description of early need recognition, resource redistribution, operational experience, and refined multidisciplinary clinic structure to support COVID-19 survivors: the Johns Hopkins Post-Acute COVID-19 Team (JH PACT).

AVAILABLE SYSTEM RESOURCES

The first COVID-19 admission to the Johns Hopkins Hospital was reported in March 2020. Swiftly rising inpatient admissions drew heavily on inpatient resources, and Pulmonary and Critical Care Medicine (PCCM) providers were immersed in frontline care. Infection control efforts reduced

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Requests for reprints should be addressed to Emily Brigham, MD MHS, Department of Medicine, 5501 Hopkins Bayview Circle, 2nd Floor Pulmonary Clinic, Baltimore, MD 21224.

E-mail address: ebrigham@jhmi.edu

availability of post-acute and ambulatory rehabilitation centers; provider resources were reallocated to augment in-hospital rehabilitation programs and support safe discharges. Non-COVID-19 research, outside of select clinical trials, was largely halted, and thus, clinical effort was expanded for many faculty members who traditionally serve in dual clinical and research roles.

ANTICIPATED AMBULATORY NEEDS

Potential ambulatory needs of COVID-19 survivors were extrapolated from other viral respiratory diseases, including severe acute respiratory syndrome (SARS) coronavirus, Middle East respiratory syndrome (MERS) coronavirus, and influenza;¹¹⁻¹⁵ data are notably limited. Patients developing acute respiratory distress syndrome (ARDS) were anticipated to be at risk for long-term respiratory complications,¹⁶ and there were emerging reports of potential complications in multiple organ systems.⁸ Importantly, survivors requiring hospitalization, especially in the ICU, were anticipated to be at risk for markedly impaired strength/physical ability, worsened mood/anxiety/post-traumatic stress disorder symptoms, cognitive impairment, and increased use of health care resources.^{3,4,17,18} Importantly, aspects of the COVID-19 pandemic, including visitor restrictions, potential limitations on essential rehabilitation services, higher levels and longer duration of sedation during critical illness, and longer lengths of stay had the potential to further complicate recovery.² Hence, a multidisciplinary approach was needed to address the needs of a rising population of COVID-19 survivors.

A rapidly developed solution was conceived to: 1) support the recovery of patients in the ambulatory setting, 2) prevent the additional burden of predicted readmissions on an already strained inpatient system, 3) understand the natural history of disease, and 4) funnel therapeutic opportunities to patients. A key consideration was the provision of ongoing care to uninsured and underinsured patients and

collaboration with language translation services, given the disproportionate burden of COVID-19 in traditionally under-resourced populations.¹⁹⁻²¹

Opportunity

The procurement of a physical location for care delivery, which typically requires substantial justification within a formal business plan, can be a barrier to rapid implementation. Coordination for a multidisciplinary model requires harmonization of multiple providers and services in time and space. Rapid adoption of telemedicine on a broad scale, necessitated by infection control measures, overcame these barriers. Specifically, telemedicine allowed for appointments to be scheduled at the mutual convenience of patients and each of the multidisciplinary providers, circumventing the need for schedule alignment at a time of high clinical demand.

CONCEPTION AND DESIGN

The overall workflow targeted anticipated survivor streams, categorized by initial severity of illness and resultant health care utilization (Figure 1). Given predicted patient needs, the PCCM Division partnered with the Department of Physical Medicine and Rehabilitation (PM&R) to provide core assessments and direct services. Patients discharged from the ICU were eligible for JH PACT-ICU, prompting referral to both Pulmonary and PM&R (Figure 2). Patients who did not require ICU care for at least 48 hours could be referred to Pulmonary or PM&R (JH PACT-Base), depending on identified needs at the time of discharge. Patients who remained ambulatory but were identified by their primary care or another physician to have residual symptoms at 4-6 weeks post diagnosis were eligible for referral to JH PACT-Base. As an additional service, the Johns Hopkins Homecare Group Remote Patient Monitoring (RPM) team collaborated with the Office of Telemedicine and the PCCM Division to launch the COVID-19 RPM program for

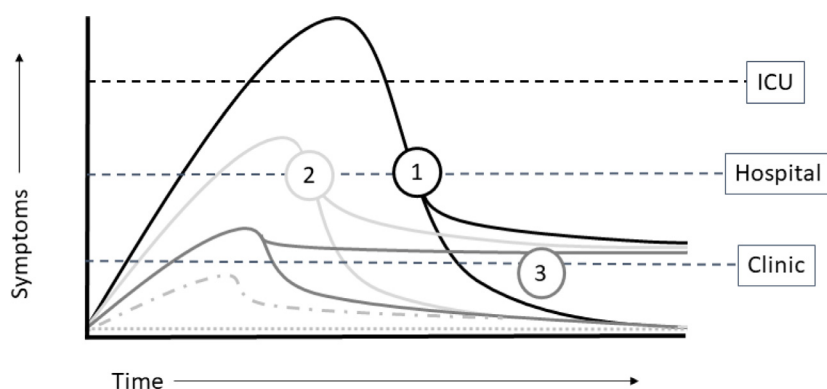


Figure 1 Schematic of anticipated COVID-19 survivor streams. Simplified depiction of anticipated COVID-19 survivor courses captured for care in the JH PACT clinic. 1) Patients recovering from intensive care unit (ICU) admission for COVID-19. 2) Patient recovering from hospitalization for COVID-19. 3) Patients who remained in an ambulatory care setting but experienced prolonged, nonresolving symptoms post COVID-19 infection.

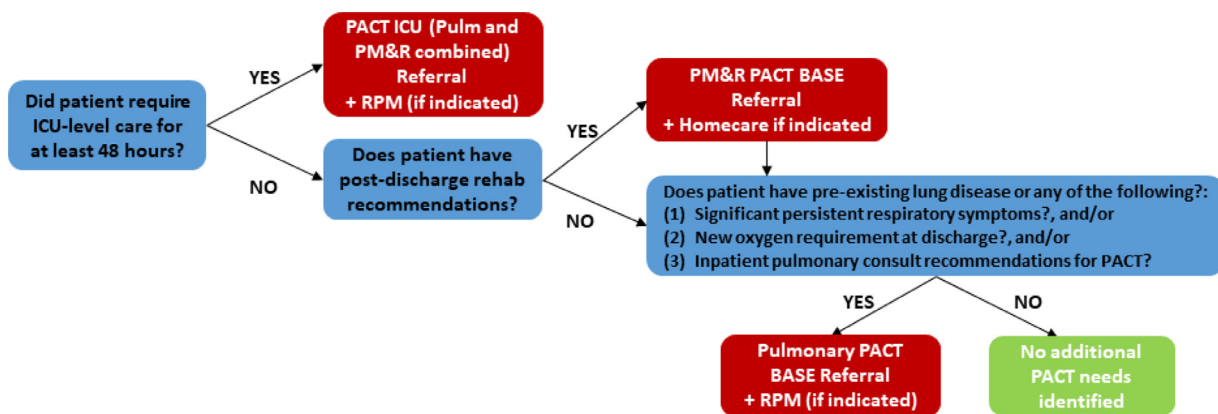


Figure 2 Johns Hopkins Post-Acute COVID-19 Team (JH PACT) referral criteria for COVID-19+ hospital discharges. Patients requiring 48 hours or more in the intensive care unit (ICU) were eligible for referral to the JH PACT-ICU, consisting of evaluation by both the Physical Medicine and Rehabilitation (PM&R) and Pulmonary services. Patients requiring hospitalization but no hospital stay were referred to JH PM&R PACT-Base with additional Homecare referral for home physical therapy/occupational therapy services if necessary. Patient then assessed for ongoing pulmonary needs or qualification for remote patient monitoring, and could receive co-referral or independent referral to JH Pulmonary PACT-Base. Patients could also be individually referred to Remote Patient Monitoring without JH PM&R or Pulmonary PACT referral (not pictured). Patients who did not require hospitalization but had ongoing symptoms at 4-6 weeks post diagnosis could qualify for referral to either of the JH PACT-Base teams.

post-hospital discharges meeting specific, predefined criteria. Pulse oximeters were deployed at the time of discharge or later delivered to the patient’s home. Oxygen saturation, heart rate, and symptoms were transmitted to dedicated clinical staff twice a day for 14 days, with the option of renewal if symptoms or vital sign abnormalities persisted.

Clinical staff responded to alerts, contacted patients for abnormalities or missed check-in, and alerted a physician on call, staffed by Johns Hopkins PCCM via a dedicated pager line.

Partnerships with key subspecialties (Figure 3) were formed early via grassroots communication with providers

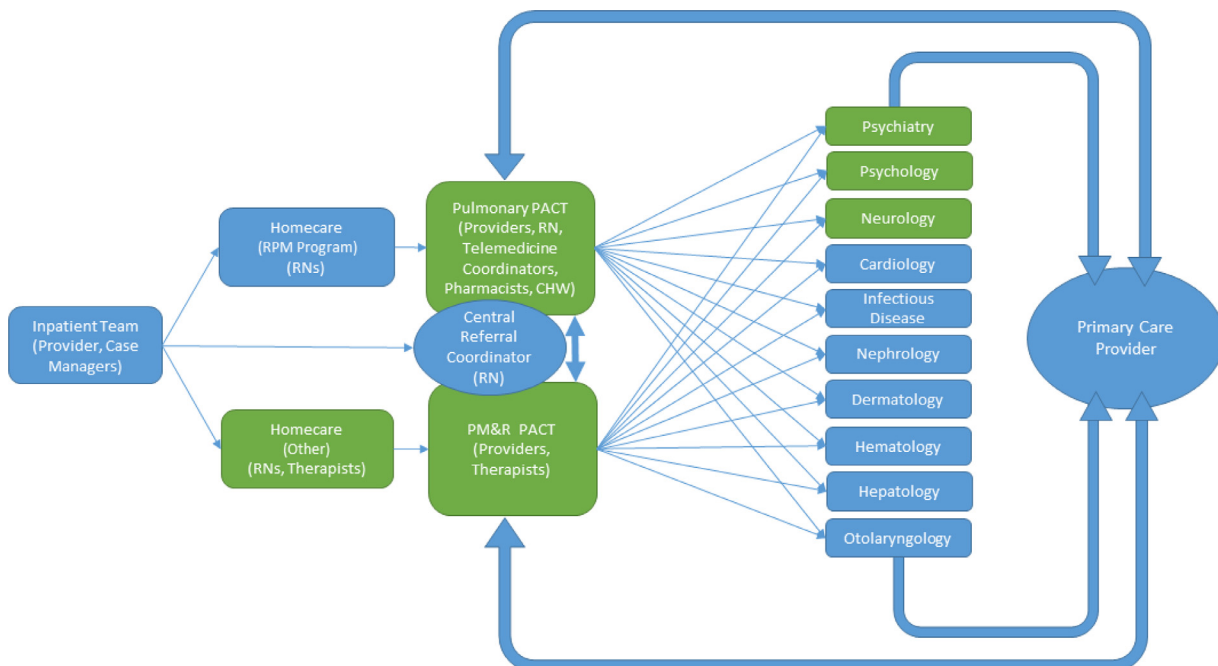


Figure 3 Key services and staff of the Johns Hopkins Post-Acute COVID-19 Team (JH PACT) clinic. Patient flow and contributing staff members represented above. Green indicates participation in weekly multidisciplinary clinic meetings. Primary care is featured prominently as an essential collaboration and line of communication. Psychology consisted of partners in both neuropsychology and rehabilitation psychology. CHW = community health worker; PMR = Physical Medicine and Rehabilitation; RN = registered nurse.

willing and interested in receiving referrals from JH PACT. This allowed for streamlined and timely referrals, established key providers for attendance at weekly multidisciplinary meetings, and allowed for development of a shared understanding of the challenges faced by COVID-19 survivors. The JH Pulmonary-PACT team further partnered with Radiology for dedicated, weekly rounds to review chest imaging, revealing typical and atypical findings and enhancing precision of clinical recommendations. Colleagues with a subspecialty focus in interstitial lung disease were invited to attend these rounds, and consulted ad hoc for complicated cases as recommended by the British Thoracic Society.^{22,23} Pharmacists completed medication reconciliation and provided recommendations via phone prior to clinic visits.²⁴ Homecare teams provided nursing and essential therapy services (physical therapy, occupational therapy, speech-language pathology) to homebound patients. Co-management and communication with primary care physicians were prioritized. For patients without primary care, networks were developed with academic and community providers to facilitate establishment of care. Hospital social workers and a community health worker were critical components in light of disproportionate representation among vulnerable populations.

Concerns were initially raised about access to telemedicine among vulnerable populations and those at risk of marginalization. To address this, research and administrative support staff were trained and re-deployed in telemedicine support to proactively contact patients, assist with software download prior to clinic, and support connection on the clinic day. Nursing staff introduced new patients to the clinic structure and assisted in navigating follow-up testing, which often required repeat COVID-19 test coordination. Clinic workflows and resources (eg, subspecialty referral

contacts) were stored in a central, secure drive accessible only by health care team members.

DISSEMINATION

A referral form (Appendix) was disseminated via a collated Department of Medicine protocol for COVID-19+ discharges. Hospital and ambulatory referrals were accepted via a centralized e-mail monitored by a referral coordinator and supported by nursing and physician review for appropriate placement in JH PACT-ICU or PACT-Base. PCCM colleagues were engaged to refer patients at the time of ICU downgrade, and clinic information was disseminated among hospitalist staff and medicine residents. Johns Hopkins Health System partners across the state were engaged in providing care under variably adopted portions of the framework, including RPM, offering an enhanced structure for post-COVID-19 care at participating hospitals.

The first JH PACT patient was seen on April 7, 2020, representing one of the earliest dedicated COVID-19 survivorship clinics in the nation. As of November 11, 2020, 265 unique patients have been seen in 530 visits by the JH PM&R or Pulmonary PACT. New patient JH Pulmonary PACT visits have generated an average of 1 (range 0-3) additional subspecialty referral per patient over the preceding month.

ONGOING MISSION

The JH PACT clinic exemplifies the Johns Hopkins tripartite mission: patient care, research, and education. To optimize clinical care and ensure rigor and uniformity of evaluation across the dedicated staff in the clinic, we adopted standardized clinic templates. Assessments were standardized consistent with the Core Outcome Measurement Set for acute respiratory failure²⁵ (improvelto.com); Society of Critical

Table Standardized Functional and Symptomatic Assessments

Domain	Instrument	Specialty	Visit Type	
			Base	ICU
Health-related quality of life	EQ5D PROMIS†	Pulmonary PM&R	x	x
Mental health				
Depression	PHQ9*	Pulmonary and PM&R	x	x
Anxiety	GAD7*	Pulmonary and PM&R	x	x
PTSD	IES-6	Pulmonary		x
Cognition	Telephone cognitive battery	Pulmonary	x	x
Pain	EQ5D pain question	Pulmonary	x	x
Physical function	AM-PAC surgical short form	PM&R	x	x
Respiratory symptoms	BCSS, mMRC	Pulmonary	x	x

Instruments are assessed at new and follow-up visits.

AM-PAC = Activity Measure for Post-Acute Care;³² BCSS = Breathlessness Cough and Sputum Scale;³⁴ EQ5D = EuroQol 5D;²⁵ GAD-7 = General Anxiety Disorder-7³⁰; ICU = intensive care unit; IES-6 = Impact of Event Scale-6³¹; mMRC = modified Medical Research Council;³⁵ MOCA = Montreal Cognitive Assessment²⁵; PHQ-9 = Patient Health Questionnaire-9²⁹; PM&R = Department of Physical Medicine and Rehabilitation; PROMIS = Patient-Reported Outcomes Measurement Information System.³³

*Instruments differ from the core outcome measurement set for clinical research in acute respiratory failure survivors (see improvelto.com) due to licensing and cost associated with the Hospital Anxiety and Depression Scale (HADS).²⁸ Telephone cognitive battery: Cognitive assessments are derived from the Multi-Ethnic Study of Atherosclerosis (MESA);³⁶ battery has been successfully implemented in diverse patient populations and is available in both English and Spanish language translations.^{37,38}

Care Medicine Consensus Statement,²⁶ and COVID-19-specific recommendations by the European Respiratory Society/American Thoracic Society.²⁷ Symptoms are assessed via validated questionnaires preclinic by telemedicine coordinators or via secure messaging and patient self-completion with incorporation into the medical record (Table).^{25,28-38} This approach allows for standardization of care, collation of clinical experiences, and description of the natural history of COVID-19 in the JH PACT population. Laboratory, pulmonary function testing, and imaging follow-up are obtained based on individual indications, though most consistent with British Thoracic Society recommendations.^{22,23} Research partnerships have proven synergistic in provision of clinical resources; we are pursuing additional funding to comprehensively characterize outcomes within this population. Further, trainees routinely rotate through the clinic, providing opportunities for clinical education and research. Importantly, trainees voice appreciation for the ability to see the post-discharge trajectory of patients they cared for in the hospital.

CONCLUSIONS

Approaches to support COVID-19 survivors vary across institutions and continents.^{23,39-42} We have described a successful multidisciplinary approach grounded in a post-intensive care syndrome/post-hospital syndrome framework.^{3,4} The rapid adoption of telemedicine, including ambulatory pulse oximetry monitoring, provided a unique opportunity to overcome traditional barriers and address disparities in care provision. While the American Thoracic Society and European Respiratory Society retain equipoise in recommendations for follow-up in a dedicated multidisciplinary clinic for post-COVID-19 care,⁴³ the present and future benefits to patients, the health system, and knowledge advancements through the JH PACT clinic are tangible. The comprehensive approach described here has proved successful in providing an enduring support network for COVID-19 survivors locally, alongside the provision of data that will inform our understanding of the natural history of COVID-19 in those requiring hospital-level care or with persistent symptoms in the ambulatory setting.

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SUPPLEMENTARY DATA

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amjmed.2020.12.009>.

APPENDIX

Referral Template
for
Johns Hopkins Post-Acute COVID-19 Team (JH PACT) and Remote Patient Monitoring (RPM)
 ****Patient must have had COVID-19 to enroll****

Check All That Apply, and return form to centralized email to complete referral.

- JH PACT Physical Medicine and Rehab Services
- JH PACT Pulmonary Medicine Services
- Remote Patient Monitoring

JH PACT-ICU or JH PACT-Base

Patient Name: _____

MRN: _____

DOB: _____

Address (if different than in medical record): _____

Best Number for patient contact (specify #, type of phone, and whose it is): _____

Does patient have a land line phone? Y/N

Does patient have a smart phone or device? Y/N

If no, does someone in the home have a smart phone or device that could be used daily? Y/N

PCP full name: _____

Home Oxygen Y/N liter flow _____ Is Oxygen New? Y/N Company _____

Did the patient require ICU-level care for >48 hours? Y/N _____

Did the patient require HFNC and/or intubation? Y/N _____

Hospital Referring MD _____

Expected Discharge Date _____

Comments: _____
