Special Communication

COVID-19 Postacute Sequela Rehabilitation: A Look to the Future Through the Lens of Chronic Obstructive Pulmonary Disease and Pulmonary Rehabilitation

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Abstract Post–COVID-19 condition is characterized by a myriad of persistent symptoms experienced up to 60 days after the acute infection, not only in those hospitalized, but also in patients with mild to moderate acute symptoms. The overwhelming evidence on multisystem involvement in post–COVID-19 condition brings to attention the need for integrated delivery models to address health care needs of this population. The World Health Organization recently highlighted critical gaps in adequately providing the level of integrative care required to address the multisystem needs of this population in current health care delivery models and recommended development of new innovative models of delivery. This article presents a novel approach to addressing these gaps from a rehabilitation perspective.

The COVID-19 pandemic affected approximately 360 million people around the world, taking more than 5.6 million lives, with disproportionate illness and poor outcomes experienced by the most vulnerable underserved populations. In the United States, nearly 14% of patients with COVID-19 were hospitalized, often requiring intensive care, external mechanical ventilation, and intubation owing to respiratory failure. Respiratory failure often occurred as a result of alveolar injury or pulmonary edema from vascular thrombosis. As providers learned how to treat respiratory failure among patients hospitalized with COVID-19, survival outcomes improved.

In the early stages of the pandemic, preventing mortality was the priority. Over time, the focus turned to treating people...
who survived COVID-19 but had persistent symptoms. In 2021, the World Health Organization identified a clinical case de-

inition of persistent sequel after acute COVID infection: post-

COVID-19 condition. Post-COVID-19 condition is character-

ized by a myriad of persistent symptoms ranging from persist-

ent fatigue, dyspnea, breathing discomfort, and chest pain to

more pronounced intensive care unit—acquired weakness, ex-

ercise intolerance, neuropathy, myopathy, arthralgia, cogni-

tive impairments, functional decline, and decreased quality of

life. Early estimates show approximately 35% of people with

COVID-19 illness may experience post-COVID-19 condi-

tion. Moreover, post-COVID-19 condition is not only isolated
to those with severe symptoms resulting in hospitalization, but

is also common among people with mild or moderate acute

symptoms.

Given the population prevalence and potential for multisys-
tem involvement in post-COVID-19 condition, integrated

health care models are needed. Furthermore, given the evi-
deence linking health disparities to health care access and

poorer outcomes, it is critical that post-COVID-19 health care
delivery models meet the needs of underserved populations.

However, the bigger question is whether our health care sys-
tems are adequately structured for integrative care. The World

Health Organization recently addressed this question, and

while new innovative models of delivery were recognized as a

critical need, no specific models were specified.

Research has highlighted that post-COVID-19 condition
could benefit from a model of care delivery such as pulmo-
nary rehabilitation (PR), yet it is unknown how to effec-
tively deliver integrated PR across health care settings. Us-
ing a model of PR for people with chronic obstructive pul-
omary disease (COPD), we propose an integrated model of

rehabilitation care with a goal to provide PR to a broad and
diverse population in need. First, we discuss the need for PR

for people who survived COVID-19. Second, we propose an

integrative model of delivery that aims to reach a diverse

patient population with post-COVID-19 condition.

Post-COVID-19 symptom sequelae: PR implications

Pulmonary dysfunction was among the most prominent early

signs of COVID-19 infection. Supplemental oxygen, acute

hospital care, and mechanical ventilation were needed for

many people with moderate to severe illness. Consequently,

COVID-19 respiratory infection and the associated postacu-
tic sequelae are strikingly similar to COPD. Emerging
evidence suggests overlapping effects of SARS-CoV-2 infec-
tion with COPD, including fatigue and dyspnea, and wide-
spread negative effects on skeletal muscle mass, physical

function, cognition, and overall conditioning.

Decreased physical activity levels, a hallmark of COPD, are

present in those with COVID, possibly as a result of social iso-
lation and “shielding” as well as from the overall effects of
deconditioning from the infection. In those with preexist-
ing pulmonary dysfunction, post-COVID-19 condition could

well aggravate the already existing symptoms and accelerate
disease progression.

Given the overlapping presentation of COVID-19 and

COPD, evidence from PR research could provide helpful

insights to the postacute rehabilitation needs of patients

with COVID-19.

Pulmonary rehabilitation

Patients with COPD show significant improvements in lung

function, dyspnea, fatigue, exercise tolerance, overall

health status, and quality of life, as well as reduced risk of

hospital readmissions and mortality, after PR. PR is de-
defined as “a comprehensive intervention based on a thor-
ough patient assessment followed by patient-tailored thera-
pies, which include, but are not limited to, exercise

training, education, and behavior change, designed to

improve the physical and emotional condition of people

with chronic respiratory disease and to promote the long-term

adherence of health-enhancing behaviors.”

Strong evidence suggests a 3-fold improvement in dyspnea, endur-
ance, activity tolerance, and overall quality of life after PR

compared with bronchodilator therapy. Owing to the evi-
dence, noninvasive nature, and no adverse effects, PR has

been reported as one of the most effective management

strategies to improve health outcomes in COPD.

Early reports of PR in patients with post-COVID-19 condition

have shown that it is a safe and feasible intervention to

improve patient-related health outcomes such as relief of

dyspnea and fatigue.

Challenges in PR delivery for post-COVID-19 condition

Despite the emerging evidence on the benefits of PR in post-

COVID-19 condition, its implementation comes with some

inherent challenges. PR is typically delivered in specialized

hospital or clinical settings that are not widely available.

Transportation to these specialized facilities therefore can

be prohibitive because of distance or lack of availability.

For these reasons, access to and use of PR has traditionally

been low even in those with COPD. Given the effect of

post-COVID-19 condition on such a large population, the

need for wider distribution of PR is imperative and warrants

new approaches to improve access.

The COVID-19 pandemic further heightened the already

existing problem of limited use of PR. Routine health care

delivery systems were significantly affected during the pan-
demic because all workforce and resources were diverted to

treating the acute infection, with less attention to the posta-
cute rehabilitation needs of individuals. In an attempt to con-

trol the spread of the virus, many PR settings were transiently

shut down because care providers reallocated workforce

staffing or were required to temporarily cease services.

Furthermore, the pandemic required clinicians to quickly

transition to some form of telerehabilitation to continue serv-

ces to patients while maintaining social distancing precau-

tions. Telerehabilitation allows for the delivery of

rehabilitation services remotely via the use of information

technology such that the provider and patient do not have to

be in the same location. Despite the great promise offered

ty telerehabilitation, delivery of a completely virtual PR

model poses several challenges. First, the successful imple-

mentation of telerehabilitation would require resources,
technologies, and supports in people’s homes, possibly requiring substantial investment. For example, delivery of PR virtually would require technology with wider views of the patients’ surroundings, such as fitting a camera in the patients’ homes and telemetric monitoring to capture physiological parameters. Second, simple video conferencing would not allow for a comprehensive assessment of exercise capacity and lung function, which are crucial for designing exercise prescription. Finally, given the cost and technology implications, a large number of patients with post–COVID-19 condition from underserved areas and those with limited knowledge of technology might not get access to this form of delivery.

Hybrid models of delivery that combine elements of tele-rehabilitation and traditional onsite care offer a good potential trade-off to ensure accurate exercise prescription and enhance access. Initial onsite physical examination and assessment followed by remotely supervised sessions could limit travel to PR sites, allowing increased access. Efficacy of hybrid PR intervention approaches, however, is unknown.

Integration of PR into postacute rehabilitation settings

PR is inherently a multidisciplinary approach including but not limited to thorough patient assessment, individually tailored exercise training, education, physical activity counseling, and behavior change to minimize long-term disability. Postacute rehabilitation facilities such as skilled nursing facilities, inpatient rehabilitation facilities, comprehensive outpatient rehabilitation facilities (CORFs), and home-health follow an interdisciplinary model of care and are poised to offer PR interventions outside of specialized hospital clinics.

Currently, the rehabilitation delivery for patients with post–COVID-19 condition in skilled nursing facilities, inpatient rehabilitation facilities, homes, and CORFs follows a traditional model more focused on functional mobility and impairments, with limited attention to disease-specific pulmonary consequences unique to COVID-19. Integration of PR in these settings would allow for a comprehensive management of patients with post–COVID-19 condition similar to what is provided for COPD. Home settings could follow one of the following delivery models: a traditional in-person home-based PR, a hybrid model to allow some onsite component for assessments and telerehabilitation, or a fully remote model wherever technological supports are well placed. A traditional in-person hospital-based outpatient PR model of delivery or a hybrid model with some telerehabilitation could be integrated within CORFs. Inpatient settings would follow a model of delivery similar to the current hospital-based outpatient PR models (fig 1). Integration of PR in postacute rehabilitation settings would also eliminate the additional step of referral to hospital-based outpatient PR facilities overcoming barriers to access because of failed referrals.

Implementation of this model would require training and supports for the rehabilitation team to deliver evidence-based PR assessment and treatment. An interdisciplinary team of nurses and physical, occupational, and respiratory therapists could be trained to deliver PR to patients with post–COVID-19 condition admitted to these facilities. The American Association of Cardiovascular and Pulmonary Rehabilitation identifies core competencies for PR professionals and offers certification training in PR. These trainings focus on (1) pulmonary anatomy, physiology, disease etiology and risk factors; (2) pulmonary-specific assessments; (3) application and interpretation of exercise tests; (4) development of individually tailored exercise prescriptions based on exercise testing; (5) comprehensive assessment of dyspnea; (6) use of standardized outcome measures; (7) oxygen therapy; (8) interventions focusing on dyspnea relief, inspiratory muscle training, peripheral muscle strength training, and aerobic exercise training; and (9) self-management strategies.

Because patients with post–COVID-19 condition may present with multisystem involvement that may require referral to specialized services, disease-specific education on screening for specific complications associated with COVID-19 including new or worsened cardiac impairment, autonomic dysfunction, exertional oxygen desaturation, and orthostatic intolerance would be crucial. Additionally, patients with post–COVID-19 condition may present with unique problems such as profound muscle weakness, hyperventilation syndrome, worsening of fatigue, cognitive dysfunction, psychological distress, and symptom exacerbation that would warrant need for individualized exercise prescription. Hypoxemia and deconditioning may be much worse in those with preexisting respiratory conditions. Such patients may need pacing of activities and additional caution during exercise progression. By training the rehabilitation team in core competencies of PR and disease-specific considerations of post–COVID-19 condition, the workforce in postacute rehabilitation facilities would be well equipped not only in managing patients that traditionally qualify for PR such as those with COPD, but also in dealing with a broad range of survivors of COVID-19.

Besides training of health care providers in the delivery of PR, postacute care facilities would require specific equipment and supplies needed for PR such as supplemental oxygen, breathing equipment, inspiratory muscle trainers, self-management and education materials, and telemetric monitoring. These facilities have the space and design conducive to incorporate these resources, making these appealing delivery sites.

Given the 358 million survivors of COVID-19, the tangible need for comprehensive rehabilitation for patients with post–COVID-19 condition is only beginning to surface. Existing PR facilities are limited in number and may not meet the growing needs of a diverse population with COVID-19. The COVID-19 pandemic exposes the vulnerability of our health care system to deliver integrated care across settings during times of national crisis, but it also creates opportunities to develop alternative comprehensive integrative community-based models of care that could facilitate access to PR across diverse populations. Training the workforce and preparing postacute rehabilitation settings for PR could address the needs of a rapidly growing body of patients. Recovery from post–COVID-19 condition will likely continue long after patients discharge from the hospital. Hospital discharge after COVID-19 is not the end of care but the beginning of a long journey of postacute care. Are we ready?
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References

1. World Health Organization. WHO coronavirus (COVID-19) dashboard. 2022. Available at: https://covid19.who.int/. Accessed March 20, 2022.
2. Tai DBG, Shah A, Doubeni CA, Sia IG, Wieland ML. The disproportionate impact of COVID-19 on racial and ethnic minorities in the United States. Clin Infect Dis 2021;72:703–6.
3. Stokes EK, Zambrano LD, Anderson KN, et al. Coronavirus disease 2019 case surveillance—United States, January 22-May 30, 2020. MMWR Morb Mortal Wkly Rep 2020;69:759–65.
4. Ackermann M, Verleden SE, Kuehnel M, et al. Pulmonary vascular endothelialitis, thrombosis, and angiogenesis in COVID-19. N Engl J Med 2020;383:120–8.
5. Soriano JB, Murthy S, Marshall JC, et al. Coronavirus disease of 2019: practical considerations for the neurosciences community. World Neurosurg 2020;139:344–54.
6. British Thoracic Society. Delivering rehabilitation to individuals surviving COVID-19 using an adapted pulmonary rehabilitation approach - BTS guidance. Available at: https://www.thoracic.org/members/assemblies/assemblies/pr/journal-club/report-of-an-ad-hoc-international-task-force-to-develop-an-expert-based-opinion.php. Accessed December 17, 2021.
7. Weltman-Stojkoski J, Knott C, Hall CE, et al. Pulmonary rehabilitation for COVID-19: a systematic review and meta-analysis. Respir Med 2021;189:106648.
8. World Physiotherapy. World physiotherapy response to COVID-19 briefing paper 9. Safe rehabilitation approaches for people living with long COVID: physical activity and exercise. London, UK: World Physiotherapy; 2021.
9. Hirsch J, Titus AR, Slocom E, et al. Population-based estimates of post-acute sequelae of SARS-CoV-2 infection (PASC) prevalence and characteristics. Clin Infect Dis 2021;73:2055–64.
10. World Health Organization. Expanding our understanding of post COVID-19 condition: report of a WHO webinar. Geneva: World Health Organization; 2021.
26. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395:497–506.

27. Guan WJ, Liang WH, Zhao Y, et al. Comorbidity and its impact on 1590 patients with COVID-19 in China: a nationwide analysis. Eur Respir J 2020;55:2001822.

28. Centers for Disease Control and Prevention. Coronavirus disease 2019 (COVID-19) cases in the U.S. Available at: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html. Accessed May 4, 2020.

29. Wu Z, McGoogan JM. Characteristics of and important lessons from the 2019 novel coronavirus in Wuhan, China. Lancet 2020;395:507–19.

30. Bain E, Harmon EY, Sonagere MB. Functional outcomes and post-discharge care sought by patients with COVID-19 compared to matched controls after completing inpatient acute rehabilitation. PM R 2021;13:618–25.

31. Nalbandian A, Sehgal K, Gupta A, et al. Post-acute COVID-19 rehabilitation. Thorax 2021;76(Suppl 1):A218.

32. Pitta F, Troosters T, Spruit MA, Probst VS, Decramer M, Gosselink R. Characteristics of physical activities in daily life in chronic obstructive pulmonary disease. Am J Respir Crit Care Med 2005;171:972–7.

33. Seidel D, Cheung A, Suh ES, Raste Y, Atakhormami M, Spruit MA. Physical inactivity and risk of hospitalisation for chronic obstructive pulmonary disease. Int J Tuberc Lung Dis 2012;16:1015–9.

34. Collins EG, Bauldoff G, Carlin B, et al. Clinical competency guidelines for pulmonary rehabilitation professionals: position statement of the American Association of Cardiovascular and Pulmonary Rehabilitation. J Cardiopulm Rehabil Prev 2014;34:291–302.

35. Li W, Pu Y, Meng A, Zhi X, Xu G. Effectiveness of pulmonary rehabilitation in elderly patients with COPD: a systematic review and meta-analysis of randomized controlled trials. Int J Nurs Pract 2019;25:e12745.

36. Neves LF, Reis MH, Plentz RDM, Matte DL, Coronel CC, Sbruzzi G. Expiratory and expiratory plus inspiratory muscle training improves respiratory muscle strength in subjects with COPD: a systematic review. Respir Care 2014;59:1381–8.

37. Salcedo PA, Lindheimer JB, Klein-Adams JC, Sotolongo AM, Falvo MJ. Effects of exercise training on pulmonary function in adults with chronic lung disease: a meta-analysis of randomized controlled trials. Arch Phys Med Rehabil 2018;99:2561–9.

38. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management and prevention of COPD. 2022. Available at: https://goldcopd.org/2022-gold-reports-2/. Accessed March 20, 2022.

39. Spruit M, Singh S, Garvey C, et al. An official American Thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. Am J Respir Crit Care Med 2013;188:e13–64.

40. Casaburi R. Pulmonary rehabilitation: where we’ve succeeded and where we’ve failed. Biophila (Fusawaja) 2017;2016:64.

41. Troosters T, van der Molen T, Polkey M, et al. Improving physical activity in COPD: towards a new paradigm. Respir Res 2013;14:115.

42. Tsutsui M, Gerayeli F, Sin DD. Pulmonary rehabilitation in a post-COVID-19 world: telerehabilitation as a new standard in patients with COPD. Int J Chron Obstruct Pulmon Dis 2021;16:379–91.

43. Bossenbroek L, de Greef MHG, Wempe JB, Krijnen WP, ten Hacken NHT. Daily physical activity in patients with chronic obstructive pulmonary disease: a systematic review. COPD 2011;8:306–19.

44. Dixit S, Borghi-Silva A, Bairapareddy KC. Revisiting pulmonary rehabilitation in elderly patients with COPD: a systematic review and meta-analysis of randomized controlled trials. Arch Phys Med Rehabil 2018;99:2561–9.

45. Falvo MJ. Effects of exercise training on pulmonary function in patients with chronic obstructive pulmonary disease. Int J Tuberc Lung Dis 2005;17:972–7.

46. Casaburi R. Pulmonary rehabilitation: where we’ve succeeded and where we’ve failed. Biophila (Fusawaja) 2017;2016:64.

47. Troosters T, van der Molen T, Polkey M, et al. Improving physical activity in COPD: towards a new paradigm. Respir Res 2013;14:115.

48. Tsutsui M, Gerayeli F, Sin DD. Pulmonary rehabilitation in a post-COVID-19 world: telerehabilitation as a new standard in patients with COPD. Int J Chron Obstruct Pulmon Dis 2021;16:379–91.

49. Bossenbroek L, de Greef MHG, Wempe JB, Krijnen WP, ten Hacken NHT. Daily physical activity in patients with chronic obstructive pulmonary disease: a systematic review. COPD 2011;8:306–19.

50. Dixit S, Borghi-Silva A, Bairapareddy KC. Revisiting pulmonary rehabilitation in elderly patients with COPD: a systematic review and meta-analysis of randomized controlled trials. Arch Phys Med Rehabil 2018;99:2561–9.

51. Grigoletto I, Cavalieri V, Lima FF, Ramos EMC. Recovery after long COVID: more than just natural recovery!? ERJ Open Res 2021;7:00454–00454.

52. Betschart M, Rezek S, Unger I, et al. One year follow-up of physical performance and quality of life in patients surviving COVID-19. BMJ Open 2020;10:e027064.

53. Gloeckl R, Leitl D, Jarosch I, et al. Pulmonary rehabilitation in patients recovering from COVID-19. Respiration 2021;100:416–22.

54. King T, Leitl D, Jarosch I, et al. Pulmonary rehabilitation in long COVID: more than just natural recovery!? ERJ Open Res 2021;7:00454–00454.
19. a prospective cohort study. Swiss Med Wkly 2021;151:w30072.

57. Kołodziej M, Wyszyńska J, Bal-Bocheńska M. COVID-19: a new challenge for pulmonary rehabilitation? J Clin Med 2021;10:3361.

58. Daynes E, Gerlis C, Chaplin E, Gardiner N, Singh SJ. Early experiences of rehabilitation for individuals post-COVID to improve fatigue, breathlessness exercise capacity and cognition - a cohort study. Chron Respir Dis 2021;18:14799731211015691.

59. Keating A, Lee A, Holland AE. What prevents people with chronic obstructive pulmonary disease from attending pulmonary rehabilitation? A systematic review. Chron Respir Dis 2011;8:89–99.

60. American Physical Therapy Association. Impact of COVID-19 on the physical therapy profession: a report from the American Physical Therapy Association. Available at: https://www.apta.org/news/2020/08/17/apta-report-pandemic-continues-disrupt-profession. Accessed May 21, 2021.

61. Rutkowski S. Management challenges in chronic obstructive pulmonary disease in the COVID-19 pandemic: telehealth and virtual reality. J Clin Med 2021;10:1261.

62. Greenhalgh T, Wherton J, Shaw S, Morrison C. Video consultations for COVID-19. BMJ 2020;368:m998.

63. American Association of Cardiovascular and Pulmonary Rehabilitation. Navigating the AACVPR program certification. 2021. Available at: https://www.aacvpr.org/Program-Certification. Accessed March 20, 2022.

64. Elfliein J. Coronavirus (COVID-19) cases, recoveries, and deaths worldwide. Available at: https://www.statista.com/statistics/1087466/covid19-cases-recoveries-deaths-worldwide/. Accessed January 10, 2022.