TABLE 1: PASC breathing discomfort assessment recommendations

#	Statement
1a	Clinicians should conduct a full patient history including review of predisposing comorbidities, characterizing course of acute COVID-19 (eg, medications received, oxygen saturation during acute illness, need for intensive care unit admission and mechanical ventilation), use of supplemental oxygen during or after acute illness, activity level since COVID-19, medications, and any new diagnoses or complications acquired following the index illness.
1b	Clinicians should systematically characterize breathing discomfort, including use of standard measures to describe and quantify the discomfort (see Discussion), and understand activity level that patients can achieve. The contribution of other factors that limit activity, including fatigue with post-exertional malaise and impaired hemodynamic response to activity (eg, inappropriate sinus tachycardia), must be considered in this activity assessment.
1c	Clinicians should assess the trajectory of breathing discomfort over time (ie, improving, worsening, or unchanged) to triage need for further workup.
2	Obtain pre-COVID-19 history including baseline respiratory symptoms and exercise capacity; obtain and review prior and recent pulmonary testing, including pulmonary function tests, chest radiograph, and chest computed tomography scan, when available.
3	In addition to full vital signs and physical exam, assess pulse oximetry while walking in a clinic office, breathing ambient air, to assess for desaturation. The pace and/or duration of exertion during this test can be increased, as tolerated and feasible.
4	Consider performing pulmonary function tests (PFTs) in patients with persistent breathing discomfort that is not improving at least 8 weeks after acute COVID-19, or in patients who develop new onset or worsening breathing discomfort later in the post-COVID course. Consider consultation with a pulmonologist for new or progressive abnormalities.
5	Chest imaging should be considered in evaluating breathing discomfort in the setting of ambulatory desaturation, abnormal pulmonary exam, impairments on pulmonary function testing, or on an individual basis for other clinical concerns. Chest radiographs are an appropriate initial study for most patients, although additional considerations are discussed within this document. Consider consultation with a pulmonologist or PASC clinic to guide imaging.
6	Transthoracic echocardiography, cardiac stress testing, and cardiopulmonary exercise testing are not routinely recommended to evaluate breathing discomfort alone after COVID-19. However, these tests may be valuable to consider in the context of a patient's associated symptoms (eg, chest pain) and treatment plan (eg, rehabilitation therapy) on an individual basis in consultation with a PASC clinic, cardiologist, pulmonologist, or pulmonary rehabilitation physiatrist.
7	Consider evaluation by an otolaryngologist for abnormal upper airway breath sounds or voice changes, including stridor, hoarseness, or unexplained episodic breathing discomfort, especially in patients with a history of endotracheal intubation and/or tracheostomy following critical illness related to COVID-19.
8	For patients undergoing rehabilitation therapy, obtain standardized measures of activity performance (see Discussion). For patients physically limited by fatigue with post-exertional malaise, neurological impairment, or other impairments, perform alternative measures of activity performance (see Discussion and refer to the Consensus Statement on Fatigue in PASC Patients).[15]

TABLE 2: PASC breathing discomfort treatment recommendations

#	Statement
1	Consider evaluation by a pulmonologist for any of the following, based on assessment recommendations: • abnormal PFTs and/or chest imaging; • abnormal pulmonary exam, which is persistent, unexplained, and/or unresolved after management in primary care setting; • persistent productive cough and/or difficulty clearing airway secretions; and • oxygen desaturation with activity. Referral to a pulmonologist for breathing discomfort in the absence of these abnormalities can be considered on an individual basis when persistent or unexplained.
2	Patients requiring home oxygen (see Discussion) should be provided a portable oxygen device whenever possible to maximize mobility, ability to participate in rehabilitation, and quality of life. Oxygen should be appropriately titrated to an ambulatory saturation range based on established standards, to facilitate progress with rehabilitation and activity.
3	Refer patients with persistent breathing discomfort resulting in activity limitation for individualized rehabilitation therapy (Figure 1): a. If patients have accompanying fatigue with post-exertional malaise and/or dysautonomia, the most physically limiting factor should dictate the pace of activity as these can be worsened by over-activity.15 b. If patients are awaiting PFTs, they can undergo general rehabilitation therapy while waiting if they are not thought to require further cardiac clearance prior to exercise. c. Consider physiological and subjective response to activity to determine the appropriate paced approach, similar to other aspects of PASC including fatigue and dysautonomia. d. Patients with PFT abnormalities meeting criteria for pulmonary rehabilitation, with associated symptoms and functional limitations, should be referred for pulmonary rehabilitation, whenever possible (see Discussion).
4	Provide breathing exercises through self-directed educational resources (see Discussion), in-person rehabilitation, or online programs.
5	For patients with breathing discomfort that is slowly improving after COVID-19, or for those without access to supervised rehabilitation, provide information (see Discussion) on self-monitored paced physical activity and breathing therapies. For patients with phone-based or wearable activity trackers, use data to track progress of therapy.
6	Instruct patients with chronic productive cough, difficulty clearing airway secretions, or with existing or new evidence of bronchiectasis regarding airway clearance techniques and consider prescribing an airway clearance device, where appropriate (see Discussion).
7	Pharmacologic therapies, including oral corticosteroids, inhaled bronchodilators, and inhaled corticosteroids, are not routinely recommended for breathing discomfort in the absence of impaired pulmonary function. Treatments may be considered when supported by objective findings (eg, examination, diagnostics). Consultation with a pulmonologist may be considered to assist this decision.

TABLE 3: Health Equity considerations and examples in post-acute sequelae of SARS-CoV-2 infection (PASC): Breathing Discomfort

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Category	Comment	What is known	Clinical considerations
Disability *Example: People with spinal cord injuries (SCI)*	Individuals with SCI are medically complex and should be treated by clinicians who have experience with this population.	Individuals with SCI often have decreased lung capacity with pre-existing breathing issues that may be due to paralysis of respiratory muscles and/or deconditioning.[73] Sleep disordered breathing is also significantly higher in people with SCI than the general population.[74] Autonomic dysfunction is also a well-described issue. A systematic review in SCI patients infected with COVID-19 suggested that intensive care unit admissions were lower, and mortality may be higher than expected—a concerning issue that deserves further attention.[75] People with SCI are known to have numerous co-morbid conditions that pre-dispose them to worse outcomes (eg, obesity, diabetes, cardiac disease). For this population, the pandemic has resulted in less access to rehabilitation services including physical therapy, reduced access to community resources with adaptive exercise equipment and opportunities, and increased social isolation with deleterious effects on mental health.	In the aforementioned systematic review, approximately one-third of patients with SCI and acute COVID-19 infection presented with dyspnea.[75] The literature is sparse regarding PASC symptoms, diagnosis, and treatment in the SCI population. Clinicians should be aware that people with higher levels of SCI (eg, cervical spinal cord) are at greater risk for respiratory compromise. Sleep-related breathing disorders should be given a high priority for diagnostic investigation. Pneumonia and other types of infections may present subtly with initial symptoms of increased spasticity. Reports providing some exercise and physical activity guidance during the pandemic for individuals with SCI have been published, and though these do not specifically address PASC, there may be some information that is helpful clinically. For example, one report suggests that individuals within SCI support groups could remind each other to engage their muscles (eg, using resistance bands) for at least 1 minute every hour.[76] Installing new adaptive equipment may be helpful and improve safety (eg, grab bars). Some individuals might have difficulty managing supplemental oxygen (ie, oxygen tubing, portable oxygen) and require adaptations or assistance. Protocols for future research that will assist with breathing related clinical recommendations in this population are underway.[77]
Insurance *Example: Individuals who are uninsured, underinsured, or cannot afford access to recommended healthcare services*	Insurance coverage, or lack thereof, should be considered when devising a treatment plan addressing breathing-related issues in PASC. Encouraging patient engagement and addressing psychosocial factors may improve adherence with treatment recommendations.[78]	People with mild to severe COVID-19 infections may experience PASC-related breathing issues. After COVID-19 infection, the predictive risk factors of pulmonary fibrosis are advanced age, smoking, chronic alcoholism, illness severity, mechanical ventilation and length of intensive care unit stay.[79] Persons with severe fibrotic lung disease after COVID-19 may require lung transplantation.[80]	Consider use of the lowest cost diagnostic testing such as chest radiograph (X ray), computed tomography (CT) of the chest, pulmonary function tests (PFTs) and treatment interventions. Some individuals may have difficulty affording generic or name brand prescription oral medication, metered dose inhalers, nebulizers, supplemental oxygen, continuous positive airway pressure (CPAP), and/or bi-level positive airway pressure (Bi-PAP) machines to assist with breathing. Long-term pulmonary follow-up may be required,[81] leading to higher healthcare costs. Referral to social services or community groups may assist persons with finding local support.

TABLE 3: Health Equity considerations and examples in post-acute sequelae of SARS-CoV-2 infection (PASC): Breathing Discomfort (continued)

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Category	Comment	What is known	Clinical considerations
▸ **Racial / Ethnic Minority Groups** *Example: People who identify as Black (including African-American), American-Indian/Alaska Native, Pacific Islander, Asian-American, and Mixed Race, and/or Latino/Hispanic (ethnicity)*	There are many reasons why the COVID-19 pandemic has a disparate impact on certain racial and ethnic minority groups, with higher rates of death in African-American, Latino/Hispanic and Native American communities.[82]	People who identify with minority groups may be at higher risk for COVID-19 infection, severe disease, and mortality. For example, one retrospective study of acute COVID-19 patients found that Hispanic individuals had a 2.76 odds ratio of decompensation and transfer to the intensive care unit within 24 hours of admission.[83] As COVID-19 disproportionately affects the case count and severity of disease in Hispanic patients, this cohort may require more respiratory related rehabilitation after hospitalization. In comparison, a crosssectional study showed that amid patients diagnosed with COVID-19, both Black race and poverty were associated with higher risk of hospitalization, but only poverty was associated with higher risk of intensive care unit admission.[84] Similarly, non-Hispanic American Indian and Alaska Native (AI/AN) persons account for 0.7% of the United States population, yet 1.3% of COVID-19 cases.85 Not only diagnosis but assessment and treatment related to breathing can be influenced by race and ethnicity. In two large cohorts, Black patients had nearly three times the frequency of occult hypoxemia that was not detected by pulse oximetry as White patients.[31] Although a discrepancy between measurements of pulse oximetry and arterial blood gas oxygen saturation was not found for all Black patients, unadjusted analysis found a discordance in 17% of Black patients and 6.2% in White patients.[31]	Racial and ethnic minority groups are more exposed to living and working conditions that predispose them to worse outcomes. Underpinning these disparities are longstanding structural and societal factors that the COVID-19 pandemic has exposed. As COVID-19 disproportionately affects the case count and severity of disease in minority groups, these individuals may require more respiratory related rehabilitation after hospitalization. Additional attention should be placed on the clinical symptoms of individuals with melanated skin tones, as the dependence on pulse oximetry alone to triage patients and adjust supplemental oxygen levels may place patients with darker skin tones at increased risk for hypoxemia.[30] For abnormal pulse oximeter readings, clinicians may consider assessing appropriate temperature of the area being tested, repeating pulse oximetry on a different extremity, encouraging deep breathing for adequate ventilation when possible or obtaining an arterial blood gas measurement. Patient clinical status and medical risk should guide individualized clinical decision making with consideration of advanced pulmonary workup when indicated.

TABLE 3: Health Equity considerations and examples in post-acute sequelae of SARS-CoV-2 infection (PASC): Breathing Discomfort (continued)

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Category	Comment	What is known	Clinical considerations
Age *Example: Younger individuals and older individuals*	Many clinical trials have gaps in the inclusion of people across the age continuum, particularly children and older individuals.	*Younger*: Breathing problems may occur in children due to underlying conditions such as asthma and this may be exacerbated by acute COVID-19 infection. The American Academy of Pediatrics has made general recommendations regarding return to play for young athletes, and these are generally based on expert opinion with much of the advice focused on when to refer to cardiology or get cardiac testing.[86] Children infected with acute COVID-19 are susceptible to Multisystem Inflammatory Syndrome in Children (MIS-C). Reports have found that some minority groups, such as Black and Hispanic children are disproportionately affected.[87] Depending on clinical cardiopulmonary symptoms related to MIS-C, some children will require a gradual return to usual activities and play.[88] *Older*: Patients in older age categories often have worse outcomes. For example, one report notes that individuals over age 55 have had increased hospitalization, delayed clinical recovery, increased pulmonary involvement, and faster disease progression.[89]	*Younger*: Clinicians should be prepared to provide medical clearance, complete school forms, pre-participation sports physical examinations, and provide additional prescriptions for medication when needed (eg, rescue inhalers - one to be kept at school, one to be kept at home, one to be kept on their person if maturity level allows). *Older*: Elderly individuals may need long term services and support after COVID-19 infection. Responsibility for this care can fall to unpaid and untrained family members at home.[90] Coordination of safe return to community care after hospitalization in the elderly population is recommended.
Environmental exposure *Example: People who live in low socioeconomic environments that expose them to various types of environment-related stressors*	Social determinants of health play a role in healthcare outcomes,[91] especially in disorders of breathing. Public health measures and health policy legislation must continue to address these factors.[92]	Cough can persist for weeks or months after COVID-19 infection, often accompanied by chronic fatigue, cognitive impairment, dyspnea,[93] or pain. Elevated levels of air pollution have shown a positive association with COVID-19 mortality rates after considering area-level confounders.[94] Air pollution may also have a negative impact on the immune system as well as exacerbations of asthma and chronic obstructive pulmonary disease.[95]	Difficulty breathing during PASC will have an impact on many areas of daily life, more compounded by the need to manage supplemental oxygen. Neighborhood factors such as the need to walk, ride a bicycle or use carpool/ride-share as means of community mobility expose additional barriers during recovery. Some individuals rely on mass transportation within the community to travel to school, work, and leisure activities. Self-care tasks requiring moderate to high physical exertion may need modification (eg, showering and dressing lifting and caring for children or pets, taking clothes to laundromat for laundering). Access to formalized physical therapy, occupational therapy and pulmonary rehabilitation may be limited due to proximity to rehabilitation facilities. Economic factors such as ability to take time off from work/school for medical evaluations and treatments/rehabilitation will also impact recovery and should be taken into consideration when developing a patient-centered comprehensive treatment plan.

TABLE 3: Health Equity considerations and examples in post-acute sequelae of SARS-CoV-2 infection (PASC): Breathing Discomfort (continued)

Category	Comment	What is known	Clinical considerations
▸ **Biologic sex** *Example: Pregnant women*	Sex differences should be considered for both the diagnosis and treatment of PASC-related breathing issues.	Pregnant women frequently have pregnancy-related breathing issues, especially during the last trimester. Deep vein thrombosis and pulmonary embolism are well documented complications in pregnancy, and women with some underlying conditions such as sickle cell disease, may be particularly at risk for pulmonary complications.[96] Pregnant women may also be at higher risk for more severe COVID-19 infections and symptoms, particularly if they have comorbidities and other characteristics (eg, older age, diabetes, obesity).[97] During the acute infection, risk assessment is critical regarding the use of medications, oxygen therapy, and other interventions as these may impact maternal and fetal outcomes.[98]	Pregnant women who have had COVID-19 infections may experience pregnancy-related breathing issues and these may be exacerbated by PASC-related breathing problems. The differential diagnosis for breathing problems should include pulmonary embolism. Pregnant women often require alternatives to diagnostic testing (eg, to avoid radiation exposure). Safety for the patient and fetus is a primary concern, and the risks and benefits of medications and other treatment interventions should be assessed by clinicians. Exercise prescriptions may be impacted by both pregnancy-related symptoms (eg, nausea/vomiting, low back pain, preeclampsia) and PASC-related symptoms (eg, dyspnea, hypoxia).

Note: This table is included to provide additional information for clinicians who are treating patients for PASC-related breathing discomfort and respiratory sequelae. This is not intended to be a comprehensive list, but rather to provide clinical examples as they relate to health equity, health disparities, and social determinants of health. The literature demonstrates that all marginalized groups face socioeconomic barriers and access to care barriers, though these may or may not be barriers for a specific individual patient. People with intersectional identities (eg, those who identify with more than one underrepresented or marginalized group), often face enhanced levels of bias and discrimination.

FIGURE 1: **Decision tree: rehabilitation approaches for breathing discomfort**

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