Review Articles

Secondary Prevention of Long COVID Symptoms: Identification, Monitoring, and Early Intervention Strategies

Gang Liu *

International Sakharov Environmental Institute, 23/1 Dzerzhinsky Street, Minsk 220004, Belarus

ARTICLE INFO

Article history:
Received 22 May 2026
Accepted 07 June 2026

Keywords:
Long COVID
Secondary prevention
Screening
Monitoring
Early intervention
Rehabilitation

ABSTRACT

Long COVID is becoming a widespread issue, as some patients endure multi-system symptoms for months or even years post-acute infection, markedly diminishing their quality of life. A purely reactive approach to symptoms overlooks key opportunities for preventive intervention. From the standpoint of secondary prevention, this article re-examines how to spot people who might deteriorate, how to dynamically monitor their condition, and how to take action before permanent functional loss happens. The definition and phenotypic distinction of long-term COVID-19 are covered in the article, along with the potential role that risk models, biomarkers, and symptom scales can have in early detection. The article focuses on early interventions for the four main symptoms—fatigue, dyspnea, cognitive impairment, and autonomic dysfunction—such as multidisciplinary rehabilitation, cognitive behavioural therapy, and digital home-based rehabilitation. It also examines how proactive follow-up and digital monitoring can identify early signs of functional decline. However, the article does not ignore real-world challenges like accessibility and equity. Overall, lowering the burden of long-term COVID requires an individualised secondary preventive approach that is started shortly after acute infection and continued throughout. However, further implementation study is needed to determine whether this pathway is practical in health systems with various contexts and resources.

1. Introduction

One unanticipated consequence of the SARS-CoV-2 pandemic is that many people's bodies have not fully healed even if their nucleic acid tests have long since turned negative. According to conservative estimates, three months after the commencement of sickness, 50%–70% of hospitalised patients and 10%–30% of non-hospitalized patients are still plagued by at least one persistent symptom [1][2].Not only are these conditions listed in medical records, but they actually make it difficult for people to go back to work and care for their families. Examples of these conditions include fatigue, growing exhausted with any movement, brain fog, shortness of breath, and palpitations. It is certainly insufficient in this situation to simply wait for people to get better on their own.

Secondary prevention—that is, early identification, early diagnosis, and early intervention—should be the main approach in the context of tertiary prevention in preventive medicine. This strategy targets people who have symptoms but are not yet severely disabled. If high-risk individuals can be identified early from the population, their functional trajectory closely monitored, and action taken before symptoms solidify into chronic disability, there is a chance to break the vicious cycle from immune dysfunction to organ damage and save significant future medical and social costs.In reality, though, most health systems have not transformed the available data into extensive action chains and are still in a "wait for patients to come" position. The purpose of this study is to give a general understanding of this chain's structure, including how to recognise, keep an eye on, and take action. It also discusses some real-world implementation issues.

2. Definition, Phenotypes, and Secondary Prevention Framework of Long COVID

Through the Delphi agreement in 2021, the World Health Organisation defined "post-COVID-19 condition" as symptoms that often start three months after a suspected or confirmed infection, persist for at least two months, and cannot be explained by other diagnosis [1]. This definition provided a benchmark for research and monitoring, but it is so broad that it may be difficult to determine who should and shouldn't be included in

* *Corresponding author: Gang Liu*
ISSN: 3071-4265/ This work is licensed under a Creative Commons Attribution 4.0 International License.
DOI: 10.64904/20260703

clinical practice.The RECOVER program examined symptom scores from more than 10,000 individuals in an attempt to "narrow down" this benchmark in 2023. It then created a threshold for the amount of symptoms and distilled a composite endpoint made up of 12 important symptoms [2]. It is a good step to identify the transition from expert agreement to operationalisation. However, this recommendation was created with the American people in mind, and it's still unclear if it will be as successful in low- and middle-income nations.

Over an extended length of time, treating COVID-19 as a single, coherent condition could lead to the one-size-fits-all error. Cluster analysis consistently identifies a number of distinct patterns, including a myalgic encephalomyelitis-like phenotype centred on persistent fatigue and post-exertional malaise; an autonomic dysfunction phenotype characterised by postural tachycardia and fluctuating blood pressure; a respiratory phenotype primarily presenting with persistent shortness of breath and decreased lung diffusion function; and a cognitive phenotype marked by significant declines in attention, memory, and executive function [3]. Finding these phenotypes is not an academic endeavour for secondary prevention; rather, it immediately dictates which individuals should receive what kind of surveillance and intervention resources.

When long-term COVID management is incorporated into the secondary prevention framework, a predetermined response sequence should be initiated when a patient shows persistent symptoms: first, use standardised tools to identify individuals who may progress to a complicated course; second, rely on routine follow-ups instead of passive waiting to catch the earliest signs of functional deterioration; and third, quickly administer early interventions already supported by evidence according to the phenotype. The underlying premise is that there is a window of opportunity to intervene between the onset of irreversible fibrosis or neurodegenerative alterations and immune dysregulation and microvascular damage. Compared to trying to address problems later, taking action now may result in much larger health advantages.

3. Early Identification: Scales, Models, and Biomarkers

3.1 Symptom Scales for Population Screening

The most practicable method for preliminary screening for suspected long-term COVID cases in a large population still depends on patients completing questionnaires. In the UK, community settings have validated the C19-YRS (COVID-19 Yorkshire Rehabilitation Scale), which considers symptom intensity, functional impact, and overall health perception [4]. Rasch analysis was used to refine the items in the SBQ-LC (Long COVID Symptom Burden Questionnaire), which can produce an overall symptom burden score and define thresholds for mild, moderate, and severe levels [5]. It is an entrance point for secondary prevention and can be finished in a few minutes at community sites or online. However, it must be acknowledged that the context of use has a significant impact on these scales' positive predictive value. Raising the threshold might be necessary at a speciality clinic to avoid rushing a large number of individuals who could eventually recover on their own towards already limited rehabilitation resources.

Table 1: Main Phenotypes, Core Features, and Recommended Interventions for Long COVID

Phenotype	Core features	Recommend early intervention measures
ME/CFS-like type (fatigue-dominant)	Persistent fatigue, discomfort after exertion, severely limited energy	Energy management (pacing), cognitive behavioral therapy (ACT-CBT), graded activity guidance
Autonomic type	Postural tachycardia, blood pressure fluctuations, decreased heart rate variability	Increase water and salt intake, compression garments, physical counter-pressure maneuvers, slow position changes
Respiratory type	Persistent shortness of breath, decreased exercise tolerance, reduced pulmonary diffusion function	Respiratory muscle training, pursed-lip/diaphragmatic breathing, intermittent low-intensity exercise, subjective fatigue control
Cognitive	Significant decline in attention, memory, and executive function (brain fog)	Cognitive compensation strategies (external reminders, simplified schedules), phased return-to-work plan

3.2 Risk Models and Predictive Factors

Numerous risk factors have been identified in numerous cohort studies, including being female, being older, having several underlying disorders (such as diabetes, autoimmune diseases, and asthma), having a high viral load during the acute phase, being seriously unwell, and being economically and socially disadvantaged [2][3]. It is only "okay" to utilise these characteristics to create predictive models based on electronic health data; individual decision-making is still a long way off. The use of biomarkers is what is genuinely somewhat fascinating. For instance, Cervia and colleagues' research revealed that certain IgG and IgM subclass responses during the acute phase are comparatively low and are strongly linked to the probability of developing long-term COVID-19 when combined with negative immune dysregulation signals [6]. The accuracy of risk models may increase if this type of immunological signal can be found in the community at a reasonable cost. Prior to that, however, a hasty implementation could just result in increased testing expenses rather than more precise triage (Figure 1).

3.3 Biomarkers for High-Risk Stratification

It is difficult to expect all clinicians to take complaints like "I'm tired" or "I can't remember" seriously. As a result, it becomes crucial to include objective indications. Among the information currently available, a number of categories of candidates stand out: circulating amyloid fibrin microclots,

which may partially explain the pathological foundation of fatigue and brain fog; consistently high levels of D-dimer and fibrinogen, which indicate problems with the microvasculature [7]. Elevated levels of neurofilament light chain add some organic notes to cognitive impairment; anomalies in the head-up tilt test or a significant decrease in heart rate variability can assist identify the physiological roots of autonomic symptoms. Naturally, these signs are not at all appropriate for routine, widespread screening. However, combining scales with important biomarkers to perform a "second-tier screening" is currently likely the most realistic method for the early evaluation of complex cases.

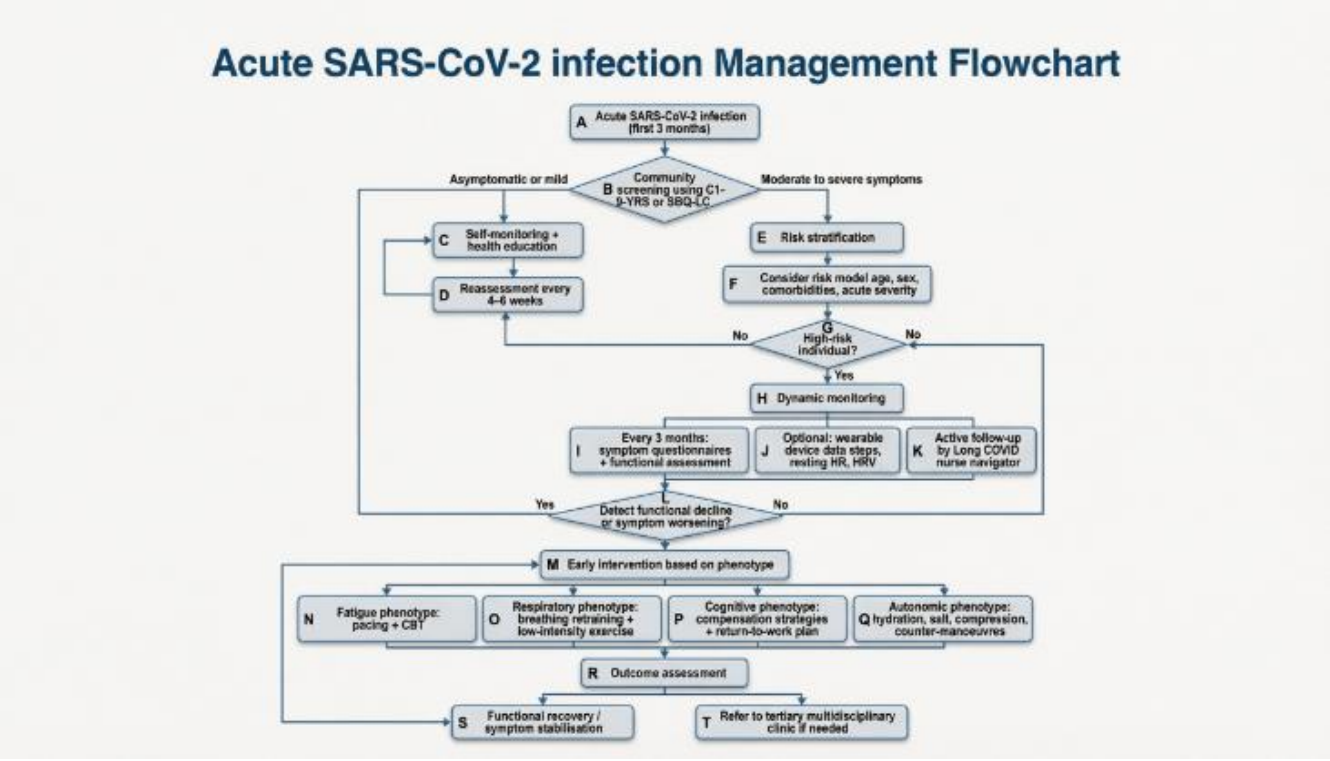

Figure 1: Secondary Prevention Pathway Flowchart for Long COVID

4. Dynamic Monitoring: Stop Sitting and Waiting

It is particularly simple to overlook the initial slope of functional loss if follow-up appointments are only made when the patient is experiencing extreme difficulty. According to the NICE guidelines, individuals who are suspected of having long-term COVID should be reassessed four to six weeks following the initial evaluation. If symptoms continue, they should be sent to a multidisciplinary follow-up pathway [8]. Every three months, large cohorts such as RECOVER collect biological samples, perform functional evaluations, and administer standardised symptom questionnaires. The findings show a worrying trend: instead of steadily getting better as we had initially believed, many people's fatigue and brain fog vary and go worse 6–12 months after infection [2]. If you don't actively monitor it, your subjective sense of gradually growing accustomed to it might easily overpower this slight decline.

A long COVID nurse navigator paradigm, which assigns a case manager to every patient who tests positive, frequently tracks symptom trajectories using scales like the C19-YRS, and promptly initiates a specialist assessment if functional scores fall, is being tested in some locations. This strategy can lower unscheduled hospital stays and ER visits, according to preliminary data. This could be the real-world model for secondary prevention.

The intervals between outpatient appointments are no longer a barrier to continuous monitoring thanks to smart wristbands and smartphone apps. Digital phenotypes such as a cliff-like decline in daily steps, an increased trend in resting heart rate, and a continuously reduced heart rate variability at night may manifest two to three days prior to the resumption of subjective symptoms. According to some research, a 48-hour early warning of a "crash" event can be obtained by utilising machine learning to analyse this kind of physiological data, providing patients valuable time to proactively decrease activity and increase rest [9]. Remote systems can produce dynamic risk signals when combined with electronic patient-reported outcomes, allowing care teams to promptly modify strategies. All of this, however, depends on patients being able and willing to regularly wear the devices and upload their data. Particularly left out in the cold by this are the elderly, people with little means, and residents of rural areas. One cannot write off the fairness of monitoring as a purely technological issue.

5. Early Intervention: Don’t Let Identification Stay Only on Paper

5.1 Fatigue Intervention

In the end, identification or monitoring must result in intervention. What use do earlier attempts serve if high-risk patients are identified but effective early treatment is not given, aside from causing anxiety?

Prolonged COVID often affects several systems, and a single department working alone is practically useless. Early in the screening process for people with moderate to severe symptom burden, a multidisciplinary team consisting of physical therapists, occupational therapists, psychologists, and respiratory and cardiac specialists, grouped according to the phenotype, should be included. The American Physical Therapy Association's 2024

guidelines state that baseline functional evaluation and submaximal exercise testing should be completed as soon as symptoms appear. The objective is to guide energy management teaching rather than immediately placing people in high-intensity training [10]. The 3Ps—pacing, planning, and prioritizing—are the frontline strategies that are used the most these days. To put it briefly, it entails educating patients about their energy limitations and using graded goals and rhythmic rest to sustain their diminishing physical capacity, so breaking the vicious cycle of pushing through—complete collapse—long-term bed rest. Results from a UK community rehabilitation cohort showed that individuals who received pacing management and self-management support in the three to six months after infection had higher levels of fatigue severity and functional independence a year later than those who only received conventional counsel [8].

Exercise isn't always the answer, and it can occasionally be harmful for people whose main issue is fatigue. In a multicenter randomised controlled study published in 2023, Kuut and colleagues used cognitive-behavioral therapy based on the acceptance and commitment therapy approach to treat patients who persisted in experiencing extreme fatigue three to twelve months after infection. The outcomes not only greatly lessened the intensity of exhaustion, but they also enhanced social engagement and physical function, and the benefits persisted six months after treatment ended [11]. In order to reduce the possibility of patients' conditions getting worse after exertion, this trial purposefully does not require patients to undergo overlapping activities. The "exercise is king" philosophy of traditional rehabilitation is corrected by this design.

5.2 Respiratory Intervention

It has been demonstrated that respiratory muscle training, pursed-lip breathing, and diaphragmatic breathing techniques, when paired with intermittent low-intensity exercises, enhance ventilation efficiency for respiratory phenotypes marked by shortness of breath and poor exercise tolerance. The submaximal idea is crucial; instead of pushing intensity based on heart rate, it should be modified based on the subjective sense of weariness. According to a network meta-analysis, compared to therapies postponed until later, supervised respiratory retraining started within six months of infection could considerably increase the six-minute walk distance [10].

5.3 Cognitive Intervention

Brain fog still doesn't have a specific medication. Occupational therapists now concentrate on cognitive compensation techniques, such as streamlining timetables, utilising outside reminders for help, and removing distractions from juggling work-related duties. A phased return-to-work plan can assist prevent illness-related labour withdrawal if cognitive impairment starts to make it difficult to keep a job. Behavioural and environmental changes continue to be the primary strategy for the time being because there is currently insufficient evidence to support the routine use of medications like modafinil in the early stages of cognitive symptoms from long-term COVID.

5.4 Autonomic Nerve Intervention

The community-based active standing test is useful for patients with orthostatic hypotension or postural tachycardia. Once recognised, a few easy and affordable strategies—drinking more water, consuming more salt, wearing compression clothing, performing physical counter-pressure manoeuvres, and slowing down the process from lying down to standing up—can frequently swiftly lower the risk of falls and ER visits without necessarily needing to wait for a specialist to intervene.

5.5 Digital Rehabilitation

Face-to-face therapy can never be enough given the size of the patient base. A recent randomized controlled trial of an online multimodal rehabilitation program for long COVID patients showed that those receiving the intervention experienced significant improvements in mental health-related quality of life, including better management of fatigue and dyspnea symptoms, compared to usual care controls [12]. By avoiding the expenses of travelling to the hospital and standing in queue, digital delivery enables patients with erratic symptoms or those who are reluctant to leave their homes to get organised support at an early stage. Patients are assisted in adhering to pacing tactics by automated feedback, daily symptom tracking, and simplified self-management plans given via text messages or app notifications. The advantages to public health could be significant if these inexpensive programs can really be included into secondary prevention pathways. However, remember to keep a window open for people without smartphones or who are unable to use them when you open the door.

6. The Difficulty of Implementation: Concerns Over Resources, Fairness, and Overtreatment

A strategy that is supported by evidence does not necessarily have to be put into action right now. There will inevitably be a number of obstacles in the way of secondary prevention of long-term COVID. The first is that there has never been a large-scale cost-effectiveness validation of the ideal cutoff values for biomarkers and screening tools in actual populations. If the threshold is set too tight, many individuals at risk of decline are missed; if it is set too wide, resources are squandered and labelling anxiety develops. Second, the disease load is concentrated at the base of an inverted pyramid of interdisciplinary rehabilitation resources; the areas most in need of services are also the ones where there is a shortage of experts who can evaluate phenotypes. While certain holes appear to be filled by digital surveillance, disparities in network coverage and digital skills are likely to make inequality worse. Third, early therapies performed too quickly may result in overtreatment because a significant percentage of patients' symptoms do resolve slowly on their own. This suggests that for secondary prevention to progressively transition from a "wide net" strategy to "targeted interception," risk prediction models must be accurate enough.

It could be more reasonable for the health system to respond in tiers rather than try to solve the problem all at once. At the system level, incorporate screening, rehabilitation, and digital monitoring into the universal health coverage service package; in primary healthcare, train general practitioners and nurses to use standardised scales and create two-way referral channels with specialised centers; in secondary healthcare, establish multidisciplinary long-COVID clinics in charge of complex assessments and targeted interventions; and conduct implementation research to determine the actual effects, costs, and acceptability of this pathway in various settings [13].

7. Conclusion

Long COVID is a newly emerging, chronic, complex illness that necessitates a shift in preventive medicine from passive response to proactive defence. Although it makes sense and has some evidence to back it, the secondary prevention pathway described in this article—early identification, dynamic monitoring, and phenotype-based intervention—is by no means a guide that can be used everywhere without modification. Pacing education, cognitive behavioural therapy, and mixed digital rehabilitation prepare tools for early intervention; numerical phenotyping converts monitoring from intermittent to continuous; and instruments such as the C19-YRS scales offer a baseline for community screening.It is still an empirical question, though, whether these techniques can yield the same advantages in settings with limited resources and a significant digital divide. Future research will probably need to focus on two areas: first, integrating multidimensional biomarkers at the biological level to improve the accuracy of prognostic judgements; second, using pragmatic trials to investigate delivery models that are both financially viable and scalable under various conditions. This is the only way we can help the innumerable people who are hindered by chronic illnesses regain some of the opportunities to resume their lives and careers.

REFERENCES

[1] World Health Organization. A clinical case definition of post COVID-19 condition by a Delphi consensus, 6 October 2021. WHO/2019-nCoV/Post_COVID-19_condition/Clinical_case_definition/2021.1.

[2] Thaweethai T, Jolley SE, Karlson EW, et al. Development of a Definition of Postacute Sequelae of SARS-CoV-2 Infection. JAMA. 2023;329(22):1934-1946. doi:10.1001/jama.2023.8823

[3] Subramanian A, Nirantharakumar K, Hughes S, et al. Symptoms and risk factors for long COVID in non-hospitalized adults. Nat Med. 2022;28(8):1706-1714. doi: 10.1038/s41591-022-01909-w

[4] Sivan M, Wright S, Hughes S, et al. The COVID-19 Yorkshire Rehabilitation Scale (C19-YRS): application and psychometric analysis in a post-COVID-19 syndrome cohort. J Med Virol. 2022;94(3):1027-1034. doi: 10.1002/jmv.27415

[5] Hughes SE, Haroon S, Subramanian A, et al. Development and validation of the symptom burden questionnaire for long covid (SBQ-LC): Rasch analysis. BMJ (Clinical research ed.), 377, e070230. doi:10.1136/bmj-2022-070230

[6] Cervia C, Zurbuchen Y, Taeschler P, et al. Immunoglobulin signature predicts risk of post-acute COVID-19 syndrome. Nat Commun. 2022;13:446. doi:10.1038/s41467-021-27797-1

[7] Pretorius E, Venter C, Laubscher GJ, et al. Prevalence of symptoms, comorbidities, fibrin amyloid microclots and platelet pathology in individuals with Long COVID/Post-Acute Sequelae of COVID-19 (PASC). Cardiovasc Diabetol. 2022;21:148. doi:10.1186/s12933-022-01579-5

[8] Greenhalgh T, Sivan M, Delaney B, Evans R, Milne R. Long covid—an update for primary care. BMJ. 2022;378:e072117. doi: 10.1136/bmj-2022-072117

[9] Radin JM, Vogel JM, Delgado F, et al. Long-term changes in wearable sensor data in people with and without Long Covid. NPJ Digit Med. 2024;7(1):246. http://dx.doi.org/10.1038/s41746-024-01238-x.

[10] Gloeckl R, Leitl D, Jarosch I, et al. Benefits of pulmonary rehabilitation in COVID-19: a prospective observational cohort study. ERJ Open Res. 2021;7(2):00108-2021. DOI: 10.1183/23120541.00108-2021

[11] Kuut T A, Müller F, Csorba I, et al. Efficacy of cognitive-behavioral therapy targeting severe fatigue following coronavirus disease 2019: results of a randomized controlled trial. Clinical Infectious Diseases, 2023, 77(5): 687-695.http://dx.doi.org/10.1093/cid/ciad257

[12] León-Herrrera S, Oliván-Blázquez B, Sánchez-Recio R, et al. Effectiveness of an online multimodal rehabilitation program in long COVID patients: a randomized clinical trial. Arch Public Health. 2024;82:159. DOI: 10.1186/s13690-024-01354-w.

[13] Davis HE, McCorkell L, Vogel JM, Topol EJ. Long COVID: major findings, mechanisms and recommendations. Nat Rev Microbiol. 2023;21(3):133-146. DOI: 10.1038/s41579-022-00846-2