Journal of Multidisciplinary Healthcare

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METHODOLOGY

Personalized Exercise Prescription in Long COVID: A Practical Toolbox for a Multidisciplinary Approach

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Video abstract

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Objective: To describe our methodology and share the practical tools we have developed to operationalize a multidisciplinary Long COVID clinic that incorporates progressive, personalized exercise prescription as a cornerstone feature.

Background: There is a lack of evidence-based guidance regarding optimal rehabilitation strategies for people with Long COVID. Existing guidelines lack precision regarding exercise dosage. As one of Australia's few established multidisciplinary Long COVID clinics, we describe our novel approach to safely incorporating exercise of both peripheral and respiratory muscles, with essential monitoring and management of post-exertional symptom exacerbation.

Methods: Working closely with primary health-care providers, our multidisciplinary team screens referrals for people aged 16 and older with Long COVID. Staff apply a three tier model of triage, dependent on the consumer's presenting problems. Exercise-based interventions necessitate detailed monitoring for post-exertional symptom exacerbation both in the clinic and at home. Personalized exercise prescription includes resistance training at a submaximal threshold (4–6 exercises, 3 days/week); whole-body endurance exercise titrated to the individual's progress, at an intensity 4–6/10 (Rate of Perceived Exertion); and for those limited by dyspnoea, high-intensity inspiratory muscle training using a threshold-based handheld device (30 repetitions per day, ≥50% of their maximum inspiratory pressure).

Discussion: We have used these approaches for the past 2 years in 250 consumers with no serious adverse events and promising consumer feedback. Our exercise prescription is less conservative than the methods advocated in international guidelines for people with Long COVID, and these more progressive tools may be valuable in other contexts.

Conclusion: In our experience, a multidisciplinary clinic-based approach to safely prescribing progressive exercise in Long COVID is feasible. Both peripheral and inspiratory muscle exercise can be effectively titrated to each individual's symptoms, and careful monitoring for post-exertional symptom exacerbation is crucial.

Plain Language Summary: Long COVID affects 5-10% of people following COVID infection. There is little specific guidance on how exercise can be safely prescribed in Long COVID. This paper is the first to provide a detailed description of an Australian multidisciplinary Long COVID clinic, including specific tools and guidance about how exercise can be prescribed while minimising post-exertional symptom exacerbation. The tools described could be valuable to other health facilities striving to optimise multidisciplinary care for people with Long COVID, incorporating safe exercise prescription.

Keywords: COVID, rehabilitation, multidisciplinary care, physiotherapy, respiratory muscle training

Received: 5 April 2024
Accepted: 1 August 2024
Published: 14 August 2024

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Introduction

In March 2022, our multidisciplinary team established one of Australia's few publicly funded outpatient clinics focused on recovery from COVID-19 (Coronavirus disease 2019). Approximately 5% of Australian COVID-19 survivors develop "Long COVID",[1] where symptoms persist for more than 12 weeks and negatively impact on their activities of daily living (ADL).[2] In an Australian study of consumers who survived an ICU admission with COVID-19, 39% of were still experiencing a disability at 6 months following an infection that did not exist prior to their COVID-19 infection.[3] A recent Australian Long COVID cohort study has described the persistence of problems including dyspnoea (28%) and extreme fatigue (28%).[1] While there is now some understanding of the cytokine storm involved in the initial pathophysiology of COVID-19,[4] there remains limited specific guidance about the optimal approach to rehabilitation for people with Long COVID.

Given the wide range of symptoms,[2] a multidisciplinary approach was recommended by the World Health Organization (WHO)[5] and the UK-based NICE Guidelines for COVID-19 management.[6] However, there is less clear guidance about the benefits and risks of different types of therapies, particularly pacing strategies (whereby consumers learn to manage and minimise energy expenditure) versus exercise therapy. In 2022, NICE guideline[6] stated:

> In the absence of evidence relating to people with ongoing symptoms from COVID-19 [the panel] could not make specific recommendations and it agreed to include a research recommendation to determine the effectiveness of exercise interventions for this population. (p.73)

Progressive, or graded, exercise therapy involves incremental increase in challenge over time, prescribed by trained therapists. Progressive exercise therapy is highly efficacious in improving strength and exercise tolerance, functional independence, quality of life and mental health in people with chronic lung disease,[7] chronic heart failure,[8] and stroke.[9] We and others have shown that individualised, prescribed exercise (particularly strength training) improves quality of life and reduces breathlessness even in critically unwell individuals.[10–12] Therefore, carefully prescribed, progressive exercise therapy could be a valuable treatment for people recovering from COVID-19.

However, the World Physiotherapy briefing paper on rehabilitation for people with Long COVID has explicitly recommended against graded exercise therapy.[13] This recommendation defines "graded exercise" as occurring with fixed increments over time and does not consider modifications based on the variability in individual responses. In contrast, our clinic employs trained therapists who carefully titrate progressive exercise in a dedicated rehabilitation environment with close monitoring and adaptation in response to symptoms, and with access to rapid response medical support. The recommendations against graded exercise originate in the chronic fatigue syndrome literature, or are often based on associations between symptoms and physical activity more broadly.[14] The Australian Institute of Health and Welfare has cautioned against conflating the evidence regarding chronic fatigue syndrome and Long COVID, and highlights that differences in vaccination and disease profiles around the world warrant more research in an Australian-specific Long-COVID context.[15] To date, these studies are lacking.

In contrast to the conservative guidelines and cautious approach to exercise prescription advocated internationally, a Spanish randomised trial of supervised strength and cardiovascular training in people with Long COVID[16] found that more progressive supervised exercise therapy was safe, well tolerated, and enhanced recovery more rapidly compared to strict adherence to WHO exercise guidelines.[16] A second trial in people with Long COVID has similarly demonstrated the benefits of individually prescribed strength training of respiratory muscles, compared to usual care, and no evidence of increased harm.[17]

In this context, we describe a novel methodology of a multidisciplinary Australian COVID recovery clinic that includes nuanced, personalized progressive exercise therapy as a cornerstone of treatment.

Methodology

Foundational Principles

We acknowledge each consumer as the authority on their unique lived experience of Long COVID,[18] and we validate the many traumatic ways this protracted disease may have impacted their life. Consumers remain unequivocally at the centre

of their care team across their clinic journey.[18] We value our consumers as co-creators of our knowledge and understanding of the management of Long COVID, and listen to our consumers' feedback (including surveys and interviews) to evolve and improve the service.[19]

Setting & Facilities

The University of Canberra Hospital is a specialist centre for rehabilitation, recovery and research (Figure 1). This purpose-built non-acute facility includes fully equipped gymnasiums, rehabilitation facilities and clinical treatment rooms.

Serving residents of Canberra, a city with a population of 420000 people, and a surrounding regional population of 230 000, the Post-COVID Recovery clinic operates 5 days per week (36 hours). The multidisciplinary team comprises the following clinical staff (Box 1), with additional services (eg clinical psychology, speech pathology) accessed as required.

Clinic Inclusion & Exclusion Criteria

In the absence of well-established evidence-based criteria, our inclusion and exclusion criteria are pragmatic and informed by clinical experience. The clinic treats people aged 16 and older who experience Long COVID symptoms and require coordinated rehabilitation to return to participation in ADLs. We accept referrals for residents of the region who are clinically stable and have medical clearance (as per their primary care provider or specialist) to undertake a rehabilitation program. Consumers need to have previous COVID-19 infection confirmed (or probable) and be experiencing severe impairment to participation in ADLs after severe or critical illness secondary to COVID-19 within the last 12 weeks; or be experiencing Long COVID symptoms for a period of greater than 12 weeks with impairment to participation in ADLs. Exclusion criteria include consumers who are unable/unwilling to give consent or follow instructions (including due to behavioural or mental health conditions), and consumers residing in aged care facilities with access to Allied Health review via alternate funding.

Referral Pathways, Triage Criteria & Screening

The clinic accepts referrals from general practitioners, medical officers, or allied health professionals. Referrals are triaged according to the criteria in Table 1, again based on pragmatic limitations and clinical experience. Consumers triaged as Tier 1 or 2a are invited to attend an interprofessional initial assessment clinic where they are reviewed by a rehabilitation medicine consultant and relevant allied health professionals to determine goals and plans for intervention.

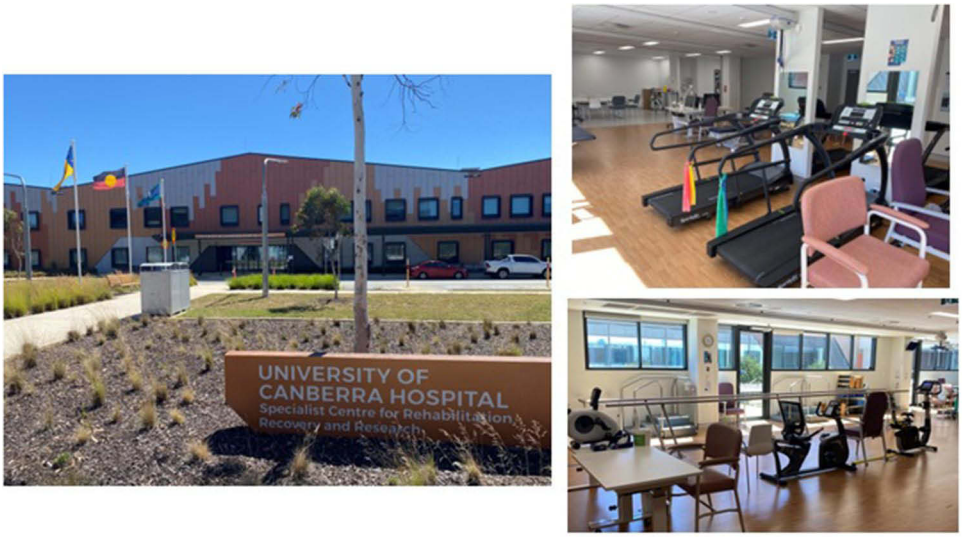

Figure 1 University of Canberra Hospital, specialist centre for rehabilitation, recovery, and research, including rehabilitation gymnasium used in the COVID clinic.

Box 1 Multidisciplinary Staffing for Post-COVID Recovery Clinic

- Rehabilitation Medicine Physician (0.2 FTE)
- Post-COVID Recovery Clinic Coordinator (1.0 FTE)
- Physiotherapist (2.0 FTE)
- Exercise Physiologist (1.2 FTE)
- Occupational Therapist (1.2 FTE)
- Allied Health Assistant (1.8 FTE)
- Dietitian (0.6 FTE)
- Social Worker (0.2 FTE

Abbreviation: FTE Full-time equivalent.

Table 1 Triage Criteria at the Post-COVID Recovery Clinic

Triage Criteria
Category 1– risk to person.
• >2 presentations to emergency services in last month for post-COVID related issues. • Age <18 with school absenteeism secondary to symptoms. • Unable to complete essential personal care independently. • Unable to complete essential household ADLs with no supports (formal or informal) • Sole carer for children under 16 at risk of harm secondary to reduced ability to participate in caring duties.
Category 2a- risk of significant functional decline. *Consumer must meet 3 or more of the criteria below for referral to be escalated (indicative of severity/burden of symptoms likely to require medical assessment)

• Financial distress due to reduced work participation.
• Unable to attend vocational training.
• Significant carer stress associated with reduced capacity to perform usual care giving roles.
• Unable to attend to essential community ADL's secondary to symptom severity (eg medical appointments)
• Fatigue:
  ○ Unable to tolerate more than 1 hour of cumulative meaningful activity per day (eg personal care only or single domestic task).
• MNA-SF= 7 or less: eating significantly less than normal and losing weight.
• Comorbidities that make consumer high risk of deterioration:
  ○ Insulin dependent diabetic and unable to manage blood glucose levels secondary to COVID symptoms.
  ○ Fatigue or brain fog impacting ability to manage food allergies.
  ○ Chronic neurological/respiratory conditions where the consumer would be at significant risk of functional decline if not assessed.
  ○ Nausea, vomiting, diarrhea, constipation, or abdominal pain significantly limiting oral intake + weight unstable New onset weight loss of more than 10% of their weight within a month or 20% in 6 months secondary to post-COVID symptoms

Category 2b – risk of not progressing with return to baseline.
• Reduced capacity to work but managing most work duties with amendments and/or a flexible work plan. • Exercise tolerance: completing half of premorbid activity, but unable to progress without therapeutic intervention. • Reducing participation in non-essential but meaningful activity (eg friends, exercise) • Weight gain secondary to reduced ADL participation post-COVID. • Weight loss of <20% in six months or <10% in one month • Smell and taste change impacting food intake. • Nausea, vomiting, diarrhea, constipation, or abdominal pain significantly changing food choices and intake, but weight remains stable • Fatigue impacting ADL participation, but consumer has appropriate social supports in place

(*Continued*)

Table 1 (Continued).

Triage Criteria
Category 3- would benefit from intervention but could be supported by primary care
• Return to leisure goals, return to sport. • Symptoms not impacting financial domains. • Requires education on progression of symptoms and self-management. • General diet advice + taste and smell changes, not impacting food intake. • Word finding difficulties

Abbreviations: ADL, activities of daily living; MNA-SF, mini nutritional assessment short form screening tool.

Table 2 Screening Tools Used at the Post-COVID Recovery Clinic

SCREENING TOOL – STANDARD MEASURES:
Modified Yorkshire COVID-19 Screening tool
Post ICU Presentation Screen- Community, Needs and Provision Complexity scale
Quality of life (EQ-5D)
Epworth sleepiness scale
Brief fatigue inventory
Mini Nutritional Assessment-Short Form (MNA-SF)
Cognitive impairment (MOCA)
Depression and anxiety screening (DASS 21)
Consumer-generated subjective global assessment
Post exertional symptom exacerbation screening
Breathlessness (Modified Borg dyspnoea scale)
ADDITIONAL MEASURES AS INDICATED:
Inspiratory muscle strength: maximum inspiratory pressure
Peripheral muscle strength: Oxford muscle grading; dynamometry
Spirometry
Functional mobility tests (eg Timed up-and-go, 10 metre walk test)
Exercise tolerance: 6 minute walk test; 1 minute sit-to-stand test
Postural Blood Pressure Screening (eg NASA lean test)
Vestibular screening

Abbreviation: MOCA, Montreal Cognitive Assessment tool.

Consumers triaged as 2b are streamed through the allied health clinic and offered a review with rehabilitation medicine only if indicated. Due to the in-depth nature of initial screening, initial appointments last 2 hours and are led by physiotherapy, exercise physiology or occupational therapy staff. The screening tools we use to identify specific problems are presented in Table 2, including the Modified Yorkshire COVID-19 Screening tool, which has been validated in people with Long COVID.[20]

During screening, any concerns regarding safety to exercise are referred to the relevant medical team (eg respiratory physician, cardiologist) who arrange comprehensive cardiopulmonary exercise testing and provide specific guidance about safety parameters. Potential triggers for referral include severe or worsening dyspnoea or hypoxia; exertional oxygen desaturation below 93% on room air at rest; exertional desaturation of 3% or more; unexplained chest pain, palpitations or arrhythmias; focal neurological signs or symptoms; or acute mental health crisis.

If consumers appear at risk of dysautonomia and/or orthostatic intolerance, they may be referred to cardiology to exclude postural orthostatic tachycardia syndrome (POTS) but meanwhile are often able to commence treatment at the clinic with pacing/education and incidental activity as tolerated. Where consumers have specific needs requiring specialist input beyond the core clinical team, they are connected with allied health input according to the referral criteria in Figure 2.

Intervention

Care provided at the clinic encompasses clinical assessment, managing comorbidities, medical management, coaching in self-management strategies, safety netting and referral (eg social work assessment), social support (including financial and cultural) and addressing mental health needs. The format is, typically, a combination of individual sessions with allied health professionals or medical staff; and when deemed safe to progress, participation in group therapies such as pulmonary rehabilitation-style exercise and education. While informed by the limited guidelines available,[21] interventions were also chosen to draw on the team's extensive experience in the context of intensive care,[22,23] cardiac and pulmonary rehabilitation.

Consumers at Tier 1 can attend the clinic up to 4 days per week for a maximum of 4–5 hours. For Tier 2 consumers, individualised exercise programs are prescribed, progressed, and monitored by an exercise physiologist or physiotherapist initially on an individual basis, then in a supervised group setting. The group program consists of twice weekly 60-minute sessions, with a complementary home exercise program to enable self-management. A multidisciplinary information session focusing on self-management strategies is delivered once a week in conjunction with the group exercise session.

For consumers for whom participation is severely limited by fatigue, telehealth rehabilitation is offered, and health professionals support consumers to focus on achieving in-home goals relating to essential ADLs. The clinic offers a spacing of therapy appointments and shorter appointments as needed. Education sessions are provided via telehealth for persons not attending the group program.

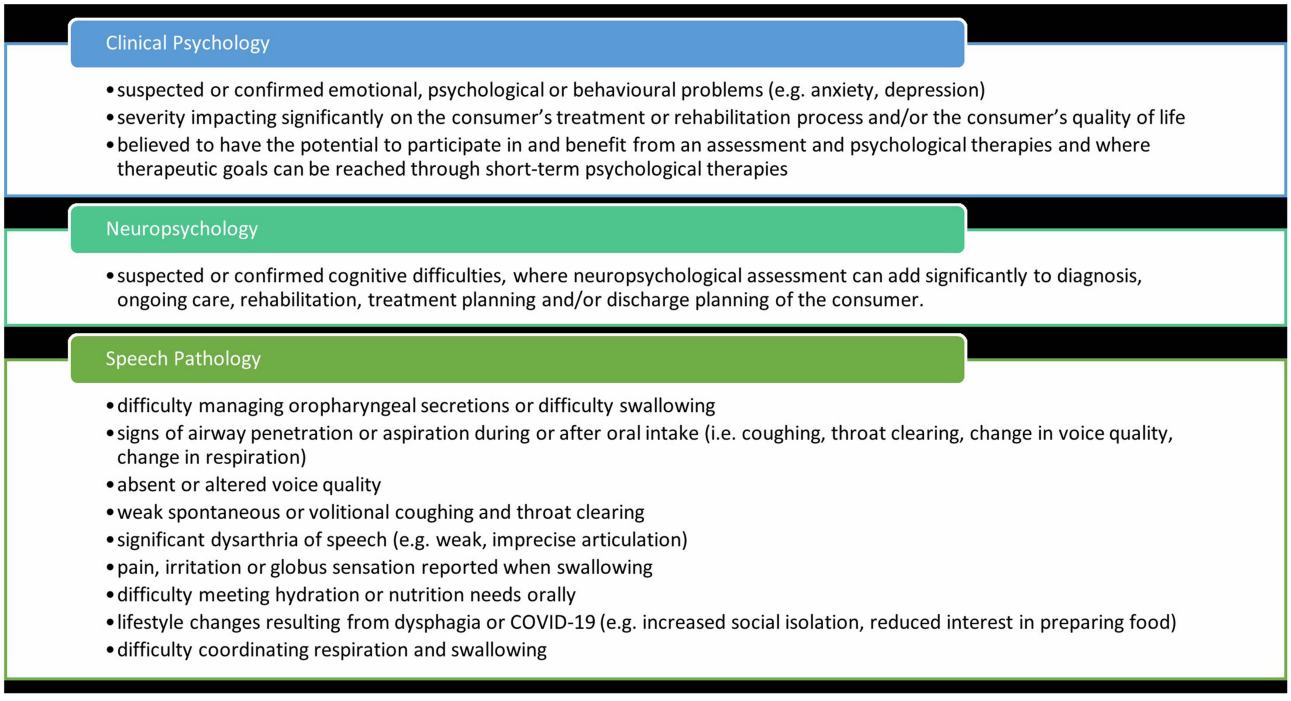

Figure 2 Referral criteria for additional multidisciplinary specialist input.

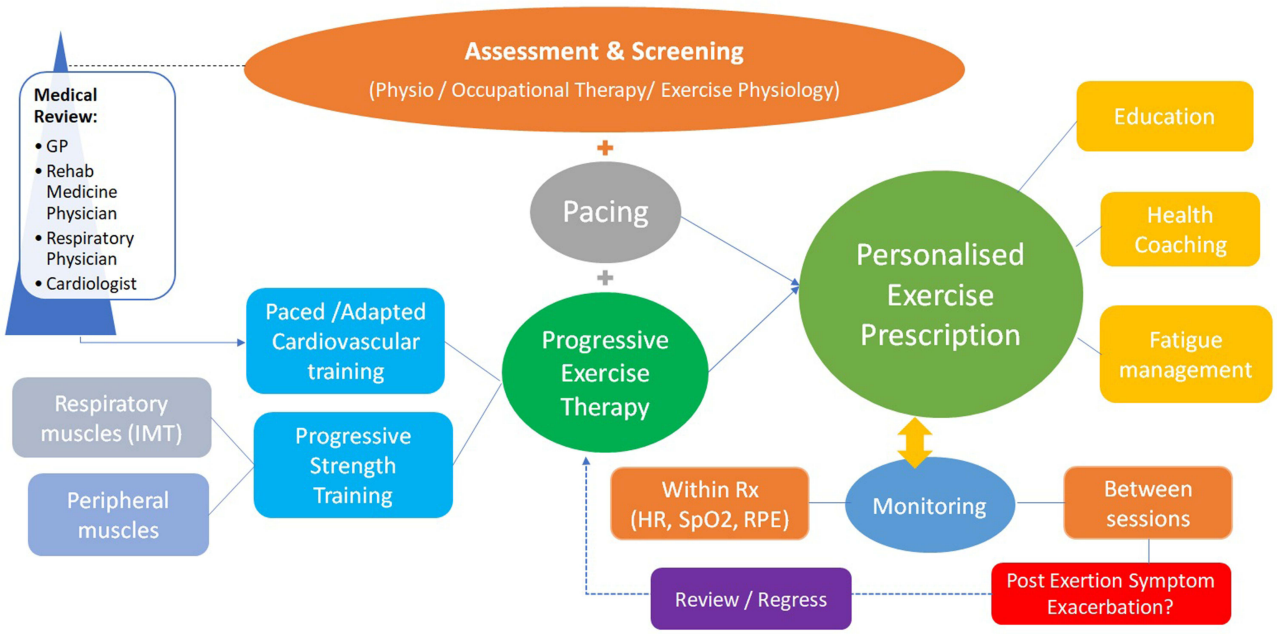

Figure 3 Model of exercise prescription in the Post-COVID Recovery Clinic.

Exercise is a cornerstone of our intervention approach in the clinic, and to be safe and effective it needs to be individually prescribed and carefully monitored (Figure 3).

Identification and Management of Post Exertional Symptom Exacerbation

Post-exertional symptom exacerbation (PESE) or "post exertional malaise" is a known risk for people with Long COVID[13,18]. PESE manifests as severe fatigue in the days following physical exertion, limiting the ability to participate in basic self-care tasks or ADLs.[21]

In our clinic, consumers are screened at baseline assessment for PESE triggered by participation in ADLs. Consumers complete a fatigue diary prior to commencement of whole-body exercise and note symptoms or triggers. All consumers receive education on PESE and report symptom flares to the prescribing clinician. For consumers experiencing PESE, the clinician provides education on activity modification and advice to use pacing strategies to ensure ADLS do not trigger symptoms (ie pacing, planning and prioritisation[21]).

Typically, these consumers are given a home-exercise program for the first 2 weeks whereby they can screen for PESE and ensure they tolerate exercise before progressing to group therapies. Activity is not progressed until they can tolerate 2 weeks of activity without PESE. Once consumers can participate in the exercise group, clinicians still check in weekly regarding PESE, and as necessary, guide the consumer to regress exercises and build back up as tolerated (Figure 3).

Personalized Exercise Prescription

The goals of exercise prescription in Long COVID are twofold: enabling return to participation in meaningful activity; and preventing secondary complications (eg muscle atrophy, pneumonia). Exercises prescribed in the clinic include:

a) Resistance training:

Due to the risk of PESE, we prescribe conservative resistance training at a submaximal threshold (from Rate of Perceived Exertion [RPE] 4-6/10 as a baseline). This enables a gradual return to independent exercise, incrementally progressed in conjunction with symptom monitoring. Exercises are individually prescribed to account for the consumer's exercise history, environmental preferences (home or gym), goals and musculoskeletal injuries/comorbidities. Initial

prescription includes 4–6 functional exercises in global muscle groups to be completed 3 days per week to optimise compliance with strength training principles.

b) Whole-body endurance exercise:

In our clinic, consumers often present with reduced exercise tolerance compared to both normative data and self-reported baseline function. Prioritising participation in meaningful activity, consumers are encouraged to continue incidental aerobic exercise (e.g. walking around home) below the threshold of PESE. Once able to tolerate ADLs, low intensity cardiovascular exercise is gradually introduced with increased monitoring. Consumers with markedly reduced functional mobility may need to commence with basic resistance exercise, with only a small component of cardiovascular training. This can be short duration low intensity walking or cycling (e.g. 5–10 minutes), or an appropriate alternative for those with orthostatic intolerance. Consumers self-monitor their response to exercise (4–6 RPE). Consumers are screened for PESE at every visit, and progressions only occur once a stable baseline has been established (i.e. no PESE). A conservative approach is taken toward timing of progressions to account for a variety of PESE triggers. (e.g. emotional stress, increased social participation)

c) Inspiratory muscle training (IMT):

Dyspnoea is a common problem for people with Long COVID, reported by 25% in a study of more than 8000 people with Long COVID in the UK,[2] and 28% in a more recent Australian study.[1] Specific strength training of the inspiratory muscles reduces dyspnoea in people with COVID, both immediately following ventilator-weaning in intensive care,[24] as well as in Long COVID.[17] Despite this, to our knowledge, inspiratory muscle training is not commonly utilised in Australian Long COVID clinics.

If consumers experience dyspnoea as a limiting symptom affecting ADLs, we measure their inspiratory muscle strength (maximal inspiratory pressure, cmH_2O) with a handheld device. We then prescribe a high-intensity interval training programme with an inspiratory muscle trainer, namely 5 sets of 6 breaths at least 50% of their maximal pressure (30 breaths total) 5 days per week (Figure 4). Consumers gradually increase the resistance on their device to feel challenged to complete the 6^{th} breath in each set. Anecdotally, some consumers enjoy being able to make observable progress with inspiratory muscle training even before they are ready to cope with the challenges of whole-body exercise. Notably, consumers with POTS can safely complete inspiratory muscle training while sitting in a chair.

Figure 4 Prescription of inspiratory muscle training in the Post-COVID Recovery clinic using a threshold-based inspiratory muscle trainer (photograph used with permission).

Discussion

We have presented our multidisciplinary methodology for safely prescribing progressive exercise therapy in people with Long COVID. Our methodology differs from previously published guidelines in that it provides specific types and dosages of exercise (incorporating both respiratory and peripheral muscles), which have proved to be safe in our clinic. This methodology is more precise and specific than previous guidelines, which have largely advocated cautious energy conservation strategies for people with Long COVID,[13] or only broad descriptions of exercise approaches,[21] or do not include respiratory muscle training.[13,21] Thus, our presented methodology is the first that incorporates the essential elements of individualised monitoring for symptom exacerbation, whilst also providing the appropriate challenges of both endurance and strength training for people with Long COVID.

There are several limitations of our model. Our clinic does not prescribe exercise for people at either end of the physical ability spectrum, for example, either extremely debilitated consumers, or those wishing to return to high-end athletic performance. There is a need to develop services to address the needs of these people, and experience from other health professionals would be valuable to inform safe and effective approaches here.

Our description has not included quantitative analysis of the efficacy of our exercise interventions, and like others,[1] we do not have a meaningful control group with which to compare our findings. However, at 18 months following clinic inception, more than 250 consumers have engaged with our clinic, and none have experienced serious adverse events as a result of the multidisciplinary exercise prescription we have described. Meanwhile, we are capturing core outcomes including exercise data, quality of life, cognitive function and return to work levels.[25] We have obtained local funding to analyse the feasibility and safety of our model and this is underway. We have also analysed 15 in-depth interviews with clinic completers to ascertain the acceptability of the model (under review). We intend to publish these results rapidly such that others can compare their findings.[1,26] Meanwhile, our description of the exercise rationale and specific interventions may prove useful to clinicians seeking guidance regarding safe and feasible exercise prescription in this novel cohort. The essence of our exercise approach (as described in Figure 3) should be readily translatable to other contexts, even in the absence of comprehensive clinic funding.

We have not described the extensive cognitive rehabilitation therapy, which is also crucial to recovery for many people with Long COVID, and is expertly provided by our occupational therapists. Future studies will explore cognitive therapies that are feasible and effective in augmenting comprehensive recovery in people with Long COVID in an Australian context.

Future studies must include both quantitative and qualitative analysis of the outcomes of this methodology, which will allow comparison with other approaches. Our understanding of the management of Long COVID will continue to evolve, and we anticipate that the needs of consumers will likely mirror those with post-viral illness or post-intensive-care-syndrome.[27,28] In this space, we continue to work as a multidisciplinary team, committed to consumer-centred and evidence-based approaches to optimising health care for people with Long COVID.

Conclusion

We have presented an approach to personalised exercise prescription for people with Long COVID that incorporates not just monitoring and pacing to avoid symptom exacerbation, but goes beyond this to incorporate specific dosages of strength and endurance exercises, targeting both peripheral and respiratory muscles. In our experience, this approach is safe in our first 250 consumers to engage with our Long COVID clinic, as there have been no serious adverse events over 2 years. We hope that the clinical reasoning and practical considerations described will enable clinicians around the world to prescribe personalised exercise to people with Long COVID, with genuine multidisciplinary collaboration and incorporation of consumer perspective at the heart of the approach.

Acknowledgments

The research team acknowledges the support of the Canberra Hospital Private Practice Fund, and the Exercise and Sports Science Australia research grant in the projects referred to in this paper.

Ethics Approval

This review and methodology article does not include any human data and therefore does not require ethical approval. The studies referred to within the paper have obtained ethical approvals that are available on request.

Disclosure

The authors declare that they have no conflicts of interest for this work.

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