Post Covid-19 Exercise Rehabilitation

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Conflict of Interest

None

Objectives

Understand the multi-system impacts of Covid-19

Have an approach to rehabilitation interventions for acute, post-acute and chronic sequelae of covid-19

Be able to assess for affected systems and functional deficits

Be able to prescribe appropriate interventions based on assessment of affected systems

Patient Case

79yo male with +comorbidities: fully vaccinated

PMHx: Type 2 DM, myasthenia gravis (dx 9 years prior, primary ocular: symptoms, tx with 10mg prednisone daily), atrial fibrillation, SVT ablation, pacemaker (inserted 2019), amiodarone lung toxicity, asthma/COPD, hypertension, dyslipidemia, BPH, hip replacement, chronic kidney disease, lumbar spinal stenosis

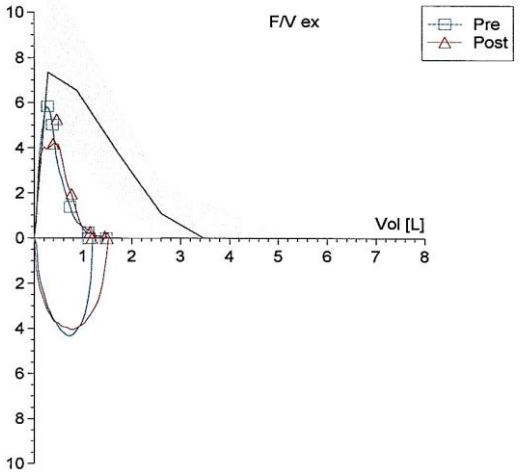
Already followed by a respirologist, baseline PFT's Feb 2021:

- FVC = 74%
- FVC/FEV1 = 76%
- DLCO = 77%

- Covid +. Admitted to ICU, tx with dexamethasone, tocilizumab, remdesivir, antibiotics and non-invasive positive pressure ventilation.
- Discharged from ICU with severe lower > upper extremity weakness, O2 desaturation and tachycardia with minimal exertion, dependent for all ADL's except feeding, non-ambulatory.
- Assessed by neurology and treated for possible myasthenic crisis.

Post-Covid PFT's May 2022:

- FVC = 43%
- FVC/FEV1 = 106%
- DLCO = 26%



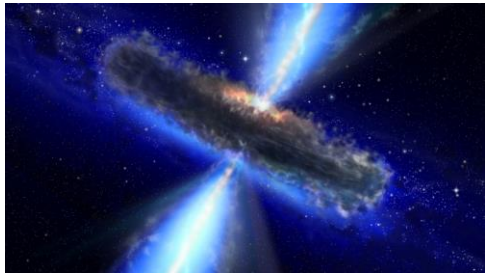
Flow-Volume Graph

A VERY brief overview of covid-19 pathophysiology

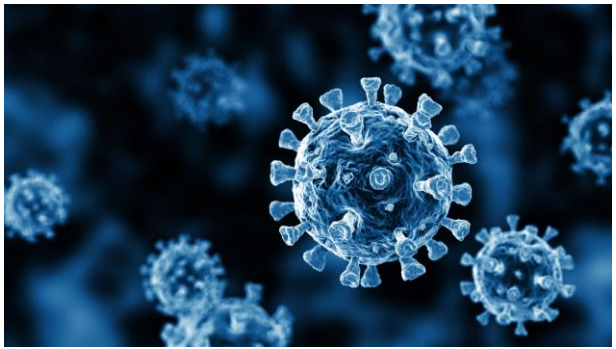
SARS-CoV-2 binds to ACE2 through the receptor-binding domain of its spike protein (transmembrane protease, serine 2 (TMPRSS2))

Direct viral damage is primarily due to massive viral-induced cell death, and loss of ACE2 actions in the entire body

Indirect effects are predominantly caused by defence mechanisms against the virus, including widespread inflammation

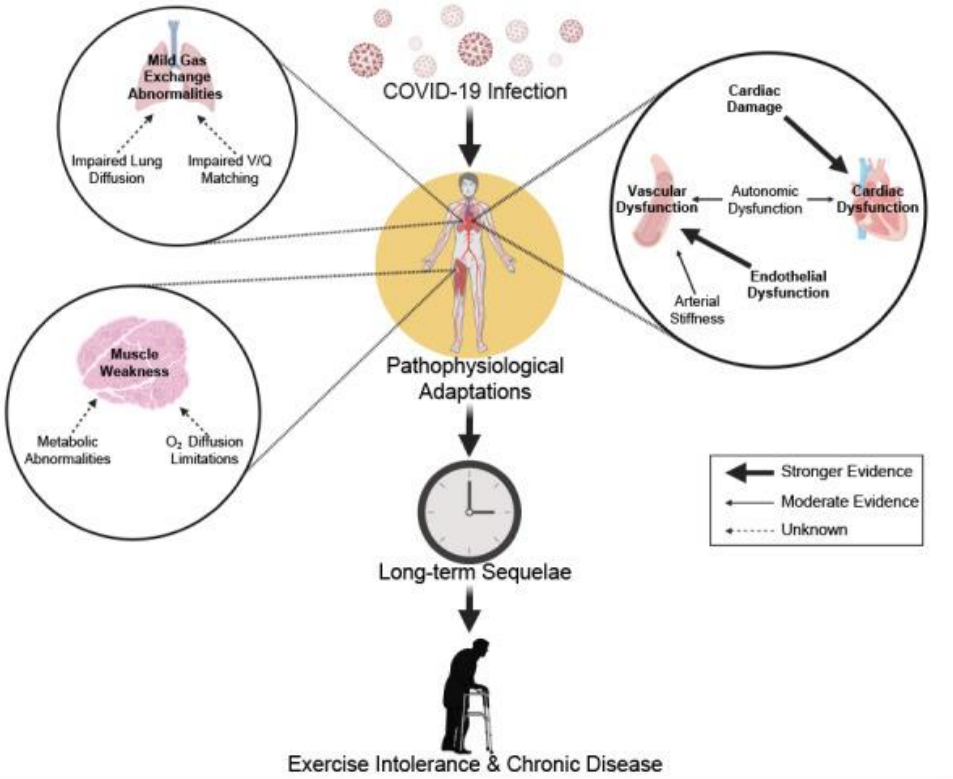


Black Hole



Sars-Cov-2

From Heart to Muscle: Pathophysiological mechanisms underlying long-term physical sequelae from SARS-CoV-2 infection



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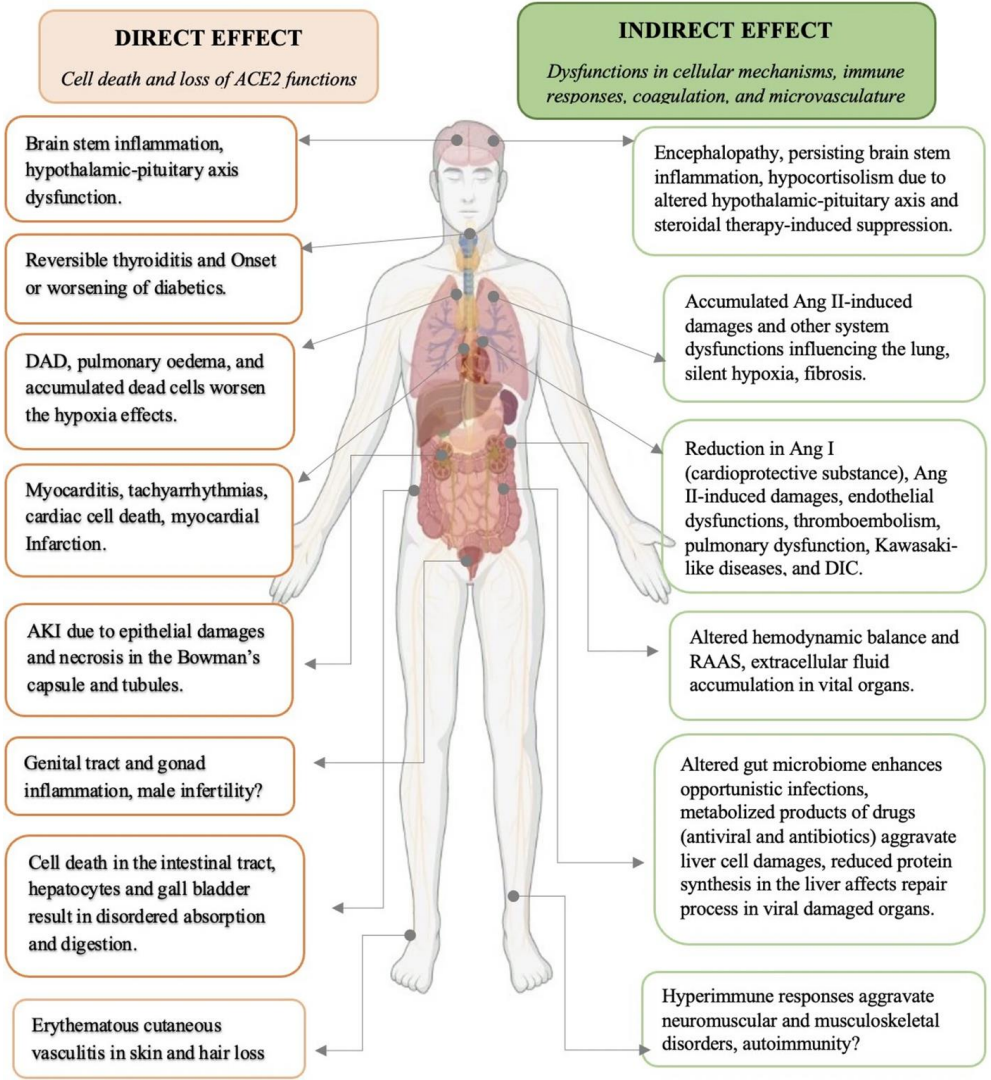

DIRECT EFFECT
Cell death and loss of ACE2 functions
INDIRECT EFFECT
Dysfunctions in cellular mechanisms, immune responses, coagulation, and microvasculature
Brain stem inflammation, hypothalamic-pituitary axis dysfunction.
Reversible thyroiditis and Onset or worsening of diabetics.
DAD, pulmonary oedema, and accumulated dead cells worsen the hypoxia effects.
Myocarditis, tachyarrhythmias, cardiac cell death, myocardial Infarction.
AKI due to epithelial damages and necrosis in the Bowman's capsule and tubules.
Genital tract and gonad inflammation, male infertility?
Cell death in the intestinal tract, hepatocytes and gall bladder result in disordered absorption and digestion.
Erythematous cutaneous vasculitis in skin and hair loss
Encephalopathy, persisting brain stem inflammation, hypocortisolism due to altered hypothalamic-pituitary axis and steroidal therapy-induced suppression.
Accumulated Ang II-induced damages and other system dysfunctions influencing the lung, silent hypoxia, fibrosis.
Reduction in Ang I (cardioprotective substance), Ang II-induced damages, endothelial dysfunctions, thromboembolism, pulmonary dysfunction, Kawasaki-like diseases, and DIC.
Altered hemodynamic balance and RAAS, extracellular fluid accumulation in vital organs.
Altered gut microbiome enhances opportunistic infections, metabolized products of drugs (antiviral and antibiotics) aggravate liver cell damages, reduced protein synthesis in the liver affects repair process in viral damaged organs.
Hyperimmune responses aggravate neuromuscular and musculoskeletal disorders, autoimmunity?

Possible Presenting Signs & Symptoms of Covid-19

Most common: fever, cough, fatigue, anorexia, shortness of breath, myalgias, sore throat, nasal congestion, headache, diarrhea, nausea, vomiting, anosmia, ageusia

Potential neurologic symptoms: dizziness, agitation, weakness, seizure, stroke symptoms, sensory loss, balance difficulties

Atypical symptoms: fatigue, reduced alertness, decreased mobility, confusion, absence of fever

Risk Factors for Severe Disease

Age >60: increasing risk with increasing age

Comorbidities: diabetes, hypertension, cardiac disease, chronic lung disease, cerebrovascular disease, mental disorders, chronic kidney disease, immunosuppression, obesity, cancer

Pregnancy specific risk factors: age >35, obesity, chronic medical conditions, pregnancy specific disorders (gestational diabetes, pre-eclampsia, eclampsia)

Smoking

Unvaccinated against covid-19

HIV

Protective Against Severe Disease: Physical Activity

Individuals who were active for >150min/week had lower rates of hospitalization, ICU admission, mechanical ventilation and death in comparison to those with low physical activity

This approximates to Metabolic Equivalent Task (MET) of 500

Light < 3.0 METs	Moderate 3.0–6.0 METs	Vigorous > 6.0 METs
Sitting at a desk: 1.3	Housework (cleaning, sweeping): 3.5	Walking at very brisk pace (4.5 mph): 6.3
Sitting, playing cards: 1.5	Weight training (lighter weights): 3.5	Bicycling 12–14 mph (flat terrain): 8
Standing at a desk: 1.8	Golf (walking, pulling clubs): 4.3	Circuit training (minimal rest): 8
Strolling at a slow pace: 2.0	Brisk walking (3.5–4 mph): 5	Singles tennis: 8
Washing dishes: 2.2	Weight training (heavier weights): 5	Shoveling, digging ditches: 8.5

Systemic Benefits of Exercise

The acute inflammatory response may be reduced by regular physical activity through the following mechanisms:

- Reducing the inflammatory signalling pathway mediated by Toll-like receptors
- Increasing anti-inflammatory cytokines such as Interleukin-10 and 37, which could inhibit the inflammatory cascade
- Reducing lung inflammation promoting the conversion from Angiotensin II to Angiotensin 1–7
- Activating the ACE2 receptor vasodilator pathway to reduce lung inflammation
- Restoring nitric oxide levels to counteract endothelial dysfunction.

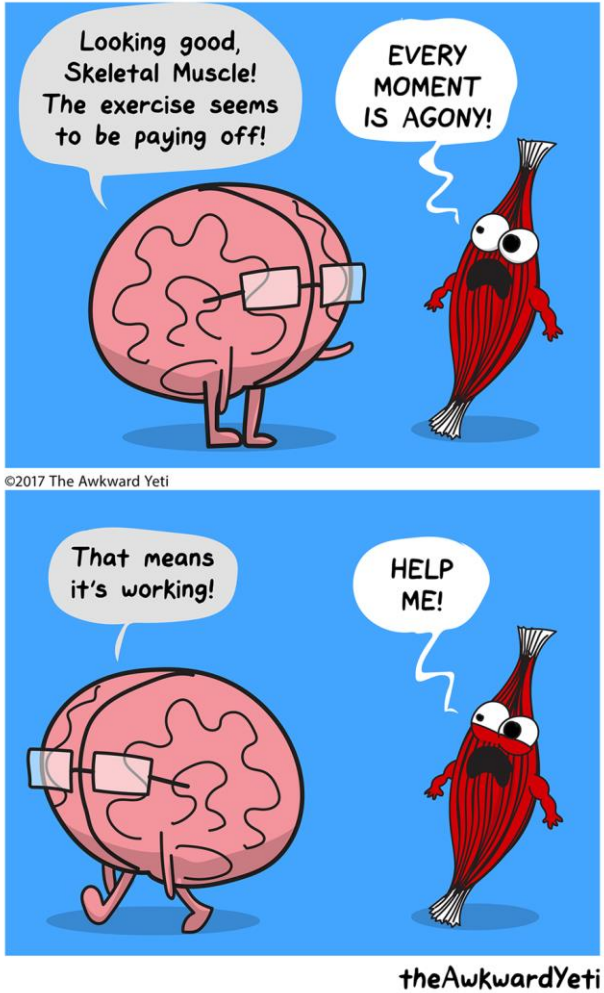
Rehabilitation Approach

Patients with physical deconditioning and muscle weakness should start with exercises that support recovery in daily functioning.

Fatigue, muscle weakness and cognitive impairment, may impact the performance of ADLs

Provide ADL training and consider home modifications and provision of assistive devices as needed.

Return to physical exercise should always be guided by symptoms.



Acute *Rehabilitation* Management of Severe Covid-19

During the acute phase of illness, the rehabilitation goal is to provide interventions that relieve respiratory distress, prevent complications and support communication.

- Respiratory interventions include prone positioning, assisted cough, positive pressure breathing devices, vibration, suctioning and manual hyperinflation
- Communication challenges may result from voice and speech disorders linked to intubation or cognitive impairment
- Benefits and risks of high ventilator settings, deep sedation, muscle relaxants, and steroids should be carefully considered prior to their use

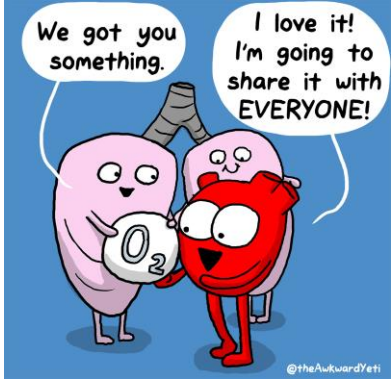
Acute *Rehabilitation* Management of Severe Covid-19

Early mobilization is recommended for all patients with risk of functional limitations resulting from frailty or ICU-acquired weakness

- Intubation is not a contraindication to active in-bed or out-of-bed mobilization
- Monitor oxygen saturation levels closely as desaturation may occur

- Therapies should ideally be provided daily, as tolerated, and progress from passive to active range of motion, side-to-side turning, isometric and resistance exercises in bed, sitting on the edge of the bed, transferring from bed to a chair, cycle ergometry and ambulation.

Post-Acute Respiratory Interventions



- Inspiratory +/- expiratory resistance devices
- Pacing education
- Breathing control techniques: high side lying, forward lean sitting, pursed lip breathing, square box breathing, nasal breathing, etc.
- Lung volume recruitment: breath stacking, manual or mechanical devices
- Cough exercises
- Cough assist devices
- Stretching exercises
- psychological support for mindfulness techniques and anxiety tolerance

Post Covid-19 Condition: WHO Definition

Post COVID-19 condition occurs in individuals with a history of probable or confirmed SARS CoV-2 infection, usually 3 months from the onset of COVID-19 symptoms and that lasts for at least 2 months and cannot be explained by an alternative diagnosis.

Common symptoms include fatigue, shortness of breath, cognitive dysfunction but also others and generally have an impact on everyday functioning.

Symptoms may be new onset following initial recovery from an acute COVID-19 episode or persist from the initial illness.

Symptoms may also fluctuate or relapse over time.

Common Post-Covid Symptoms

- New Fatigue
- Breathlessness
- Myalgias & Arthralgias
- Dysgeusia/Anosmia
- Palpitations
- Orthostatic Intolerance
- Vocal changes
- Cough
- Dysphagia
- Incontinence
- Sleep Disturbance
- Anxiety
- Depression
- PTSD symptoms
- Pain
- Problems with Concentration/Memory

Post Covid Complications

Cardiac impairment - symptoms include tachypnea, dyspnea, resting or exertional tachycardia, chest pain, and palpitations

Orthostatic intolerance - symptoms include blood pressure and heart rate variabilities with upright positions, temperature dysregulation, excessive sweating, lightheadedness, chest pain and syncope.

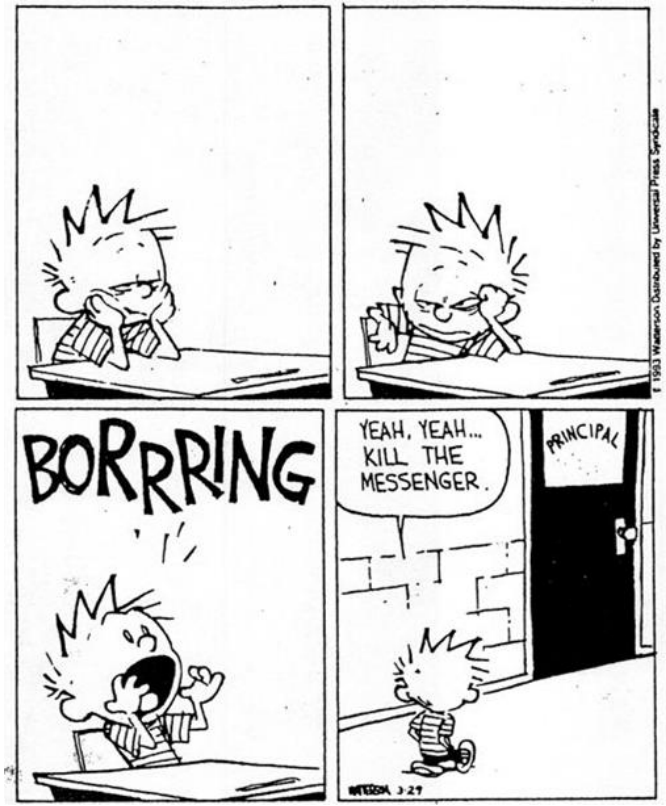
Exertional desaturation - Drop in pulse oxygen saturation of more than 3–4% from baseline or to 94% or below, on exercise tests

Post exertional symptom exacerbation **-** worsening of symptoms with minimal cognitive, physical, emotional, or social activity, or activity previously tolerated.

Post Covid Rehabilitation Assessment

A few potential functional assessments:

- Pulmonary function tests
- ECG/ cardiac biomarkers
- ECHO
- Exercise stress test
- FIM: functional independence measure
- 30 second sit to stand test
- 10 meter walk test
- BERG balance test
- 6 minute walk test
- BORG rating of perceived exertion scale
- Covid-19 Yorkshire Rehabilitation Screening tool



Post Covid Exercise Limitations:

Chronotropic incompetence during exercise

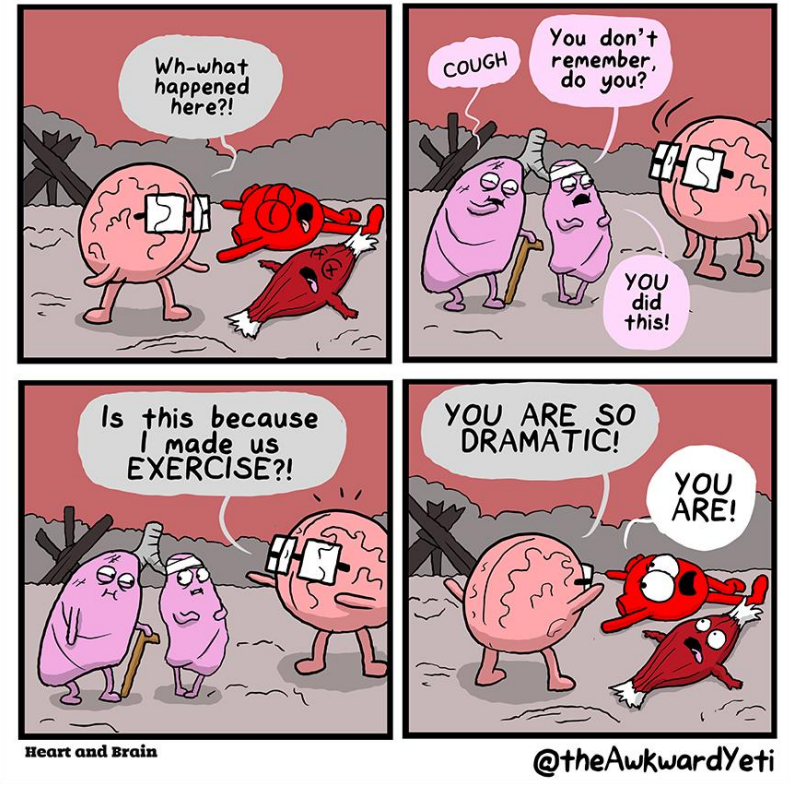
Lower stroke volume

Lower peripheral diffusional oxygen transport capacity

Lower VO2max

Altered skeletal muscle metabolism:

- lower mitochondrial density
- Lower oxidative phosphorylation capacity



Muscular Response: Deconditioning

Immobility in the setting of critical illness has negative effects on muscle structure and function.

Muscle strength can decrease by as much as 15% after two weeks of bedrest and by more than 50% after 28 days of immobilization. This is most evident in weight-bearing muscles of the lower limbs and core.

Muscle inactivity stimulates protease activation and thus leads directly to muscle breakdown, increased catabolism, and decreased contractility.

Neuromuscular problems are also common ICU-acquired complications, affecting about 40% of all patients

Muscular Response: Reconditioning

Regular physical activity leads to skeletal muscle adaptations that allow more efficient utilization of substrates for ATP production and fatigue resistance

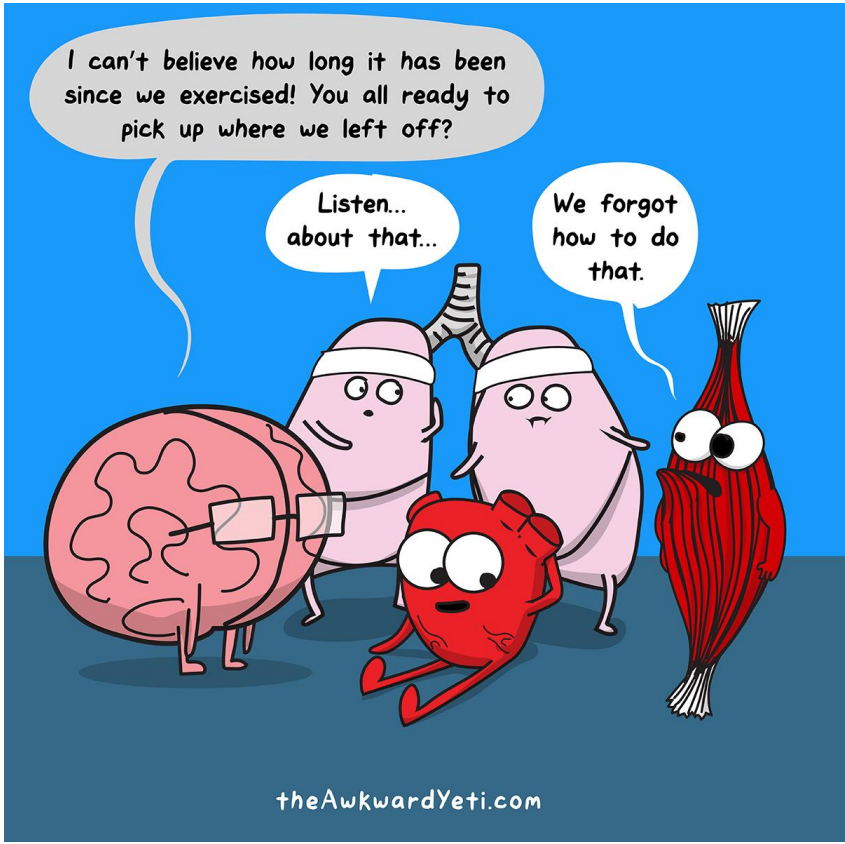
- Muscle fiber type transformation with increased expression of myosin heavy chain isoforms
- Increases in mitochondrial activity and content
- Increases in GLUT4 protein expression.

Exercise adaptations are generally evident after 8 to 12 weeks. However, there are some early changes in muscle strength and size after only 2-4 weeks.

Exercise Prescription

The basic exercise prescription consists of four variables (FITT):

- F – Frequency: Number of days each week
- I – Intensity: Low, moderate, or greater
- T – Time: Minutes per session for endurance exercise
- T – Type: Endurance, strength, mobility, or some combination



Return to Play Guidelines following Covid-19 Infection

1. Asymptomatic athlete: three days abstinence following positive test
2. Mild illness: three days abstinence from symptom onset
3. Moderate illness or cardiopulmonary symptoms: minimum five days abstinence; evaluation prior to return

Clinical evaluation required before return to play following severe illness or if cardiopulmonary symptoms were present

- If evidence of ongoing signs/symptoms consider rest for additional 4-6 weeks with re-evaluation prior to return to play
- Once resolution of signs/symptoms occurs then begin gradual, staged return to play with ongoing monitoring for recurrence of signs/symptoms

Stages of Return to Play

Stage	Activity Level	Objectives	Exercise Intensity & Examples
1	Initial Rest	Allow time for recovery	Activities of daily living
2	Light Activity	Gradual increase in heart rate	Light exercise No resistance training
3	Moderate Activity	Increase exercise frequency & duration	Increase aerobic activities Begin resistance training
4	Advanced Activity	Increase exercise intensity & restore functional skills	More intense aerobic activities More intense resistance training
5	Normal Training	Gradual resumption of standard fitness routine	Normal training Full resistance training Re-introduction of sports specific training

Back to the patient case…

- Admitted to inpatient rehabilitation: worked with physiotherapy, occupational therapy, speech language pathology, dietitian, social work and psychology.
- He was discharged home with supervision recommended for ADL's and transfers.
- After outpatient rehabilitation he is currently independent for ADL's, ambulating with a rollator.

Post Rehab PFT's:

- FVC = 77%
- FVC/FEV1= 76%
- DLCO = 42%

Benefits of Post Covid Exercise Rehabilitation

Improvements in upper and lower extremity strength

Improvement in cardiopulmonary parameters

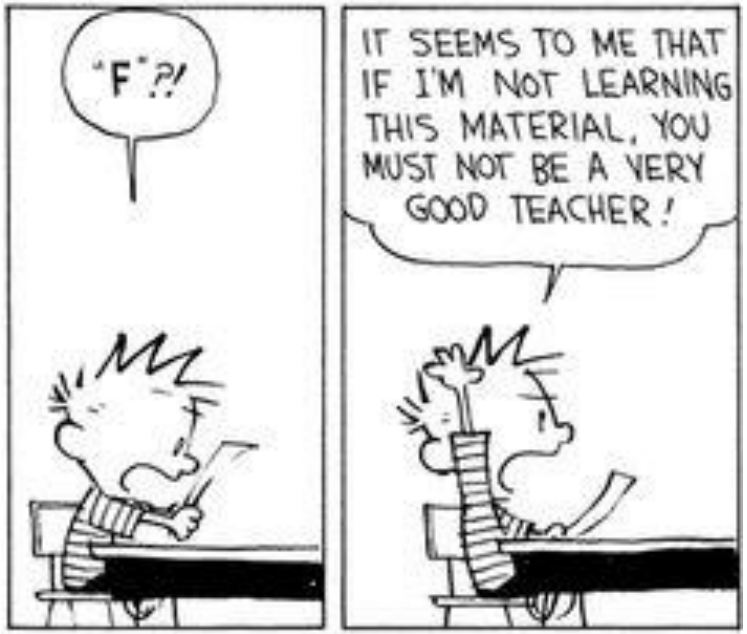
Improved perceived physical and mental health

Decrease in depression and anxiety

Decrease in fatigue

Decrease in dyspnea

Improvement in quality of life



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Thank You!
Questions?