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## Correspondence

## Anesthesia and the “post-COVID syndrome”: Perioperative considerations for patients with prior SARS-CoV-2 infection

### To the Editor:

The COVID-19 pandemic continues to present a major global health threat. Although most patients infected with SARS-CoV-2 do not develop fatal or critical illness, even mild cases may have long-term health consequences. A recent study in *The Lancet* by Huang *et al* found that, among 1733 previously-hospitalized COVID-19 patients, 76% experienced at least one residual symptom 6 months after diagnosis [1]. Symptoms ranging from chest tightness and dyspnea to anosmia and headaches have been described as part of a chronic “post-COVID syndrome.” [1,2] [Table 1].

This “post-COVID syndrome” may have significant implications for anesthetic and perioperative care, and is likely to affect a large number of patients worldwide. Very little is known about perioperative management, morbidity and mortality in patients who have recovered from COVID-19. In this paper, we summarize what is known regarding the chronic effects of SARS-CoV-2 infection, and raise key considerations for the perioperative evaluation and anesthetic management of previously-infected patients [Table 2].

### 1. Neurologic considerations

Neurologic manifestations of COVID-19 range from dizziness and headache to encephalitis, seizures and stroke and demyelinating polyneuropathy [3]. SARS-CoV-2 is also known to cause loss of smell and taste, which may reflect direct injury to olfactory neurons. Neurologic sequelae may persist beyond acute illness. In the recent *Lancet* article, Huang *et al* found that 11–13% of previously-hospitalized COVID patients experienced ongoing loss of smell after 6 months, while 7–9% reported loss of taste. In addition, 5–8% experienced dizziness, and 2–3% complained of persistent headaches [1].

Data are limited regarding optimal anesthetic management of this population. If a patient presents with evidence of peripheral neuropathy, it may be prudent to apply management strategies used in patients with other neuromuscular disorders. These include the judicious use of opiates and neuromuscular blockers (NMBs), and quantitative monitoring of NMB reversal. Avoidance of regional anesthesia may also be advisable. In some cases, patients might also be encouraged to consult a Neurologist postoperatively.

### 2. Cardiovascular considerations

SARS-CoV-2 infection is associated with significant adverse cardiovascular effects. 20–30% of hospitalized COVID patients show evidence of acute myocardial injury, potentially leading to dysrhythmias and ischemic or non-ischemic cardiomyopathy [4]. Acute cardiac involvement is associated with worse clinical outcomes in COVID-19 patients,

but chronic cardiovascular effects of COVID may also be significant [4]. Huang *et al* found that 4–10% of patients reported chest pain and 9–11% experienced palpitations after 6 months [1]. These effects may reflect myocardial fibrosis or inflammation [4]. In another study of 26 patients who complained of new cardiac symptoms following COVID-19 infection, 58% demonstrated evidence of myocardial edema and/or decreased perfusion on cardiac MRI, at a median of 47 days after symptom-onset [5].

Anesthesiologists must be vigilant of possible cardiac dysfunction in patients with prior SARS-CoV-2 infection. Surveillance EKG and TTE have been recommended for COVID-19 patients 2–6 months after acute infection [2]. A low threshold for pre-operative transthoracic echocardiography (TTE) or further evaluation may be appropriate.

### 3. Pulmonary considerations

COVID-19 may cause long-lasting pulmonary injury in patients who initially develop mild respiratory symptoms. Among patients who did not require supplemental oxygen when hospitalized for COVID-19, 22% demonstrated diffusion impairment on pulmonary function testing (PFTs) 6 months after acute infection, and 22–29% of patients performed below normal on a 6-min walk test [1]. Small-airway dysfunction and new-onset restrictive lung disease have also been described in recovered COVID-19 patients, independent of acute pneumonia severity. [6]

Anesthesiologists must remain vigilant regarding possibly compromised pulmonary function in patients with prior COVID-19. Depending on history and symptom severity, surveillance PFTs and lung imaging may be indicated [7]. If general anesthesia is planned, it may be prudent to emphasize the possibility of postoperative mechanical ventilation.

### 4. Renal considerations

Moderate or severe SARS-CoV-2 infection is frequently associated with acute kidney injury (AKI). Mechanisms of kidney damage include the pre-renal impact of systemic inflammation, as well as direct viral injury to the kidney via the angiotensin converting enzyme 2 (ACE2) receptor [1]. Renal injury may persist beyond the acute phases of COVID-19. Huang *et al* found that 35% of patients demonstrated decreased glomerular filtration rate at follow up, as did 10% of patients with no evidence of AKI in the acute illness setting [1].

Further research is needed to determine the duration of COVID-induced kidney injury, and it has been recommended that patients who develop AKI in the setting of SARS-CoV-2 infection receive medical follow-up for at least 2–3 months to monitor renal function [8]. Although COVID-induced renal injury is unlikely to be diagnosed in the

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**Table 1**  
Symptoms reported by patients recovered from COVID-19 [1,2].

Fatigue or muscle weakness
Myalgias
Sleep difficulties
Hair loss
Smell disorder
Palpitations / Tachycardia
Joint Pain
Decreased appetite
Taste disorder
Dizziness
Diarrhea or vomiting
Chest pain
Chest tightness
Sore throat or dysphagia
Rash
Headache
Anxiety
Low grade fever

**Table 2**  
Management considerations for the anesthesia provider when caring for patients with Post-COVID symptoms.

	Symptom or finding	Management considerations and strategies
Neurologic	Peripheral neuropathy	Judicious use of neuromuscular blockade (NMB) Quantitative reversal of NMB Avoidance of regional anesthesia Perioperative Neurology consult
Cardiovascular	Palpitations Chest pain Decreased myocardial perfusion	Perioperative EKG Transthoracic Echocardiogram Cardiology referral/evaluation
Pulmonary	Residual small airway dysfunction Restrictive lung disease Diffusion impairment	Avoidance of general endotracheal anesthesia Discussion of possible postoperative mechanical ventilation with patients, families and proceduralist team
Hematologic	Hypercoagulability Venous and arterial thromboses	Pre- and intraoperative thromboprophylaxis (mechanical and pharmacologic) Use of Enhanced Recovery After Surgery (ERAS) protocols to facilitate early mobilization and ambulation
Functional status	Fatigue Muscle weakness Decreased mobility	Referral to pre-operative exercise and conditioning programs

perioperative setting. Anesthesiologists should continue to pay careful attention to clinical and biologic markers of renal function when evaluating patients perioperatively. Avoidance of known nephrotoxic agents may be warranted.

## 5. Hematologic considerations

Critically ill COVID-19 patients are at particular risk of thromboses affecting all major organs, but patients with mild illness may also be affected. Large vessel ischemic strokes and acute embolic limb ischemia have been reported in young and otherwise healthy patients, at a median 78 days following initial COVID diagnosis [9].

The duration of the COVID-induced pro-thrombotic state is unknown. However, perioperative inflammation and immobility are independent risk factors for venous thromboembolism. Anesthesia providers should be aware of the elevated and possibly compounded risk of thrombosis in surgical patients recovering from COVID-19, and should follow best-practice guidelines regarding thromboprophylaxis in

the peri-operative period. “Enhanced Recovery After Surgery” (ERAS) protocols, to facilitate early ambulation and reduce venous thromboembolism risk, may be particularly important.

## 6. Frailty and decreased functional status

Frail patients have decreased physiologic reserve and significantly increased risk of postoperative complications [10]. Huang *et al* reported that 59–81% of previously-hospitalized COVID patients experienced fatigue and muscle weakness 6 months after diagnosis; between 6 and 14% of patients reported decreased mobility [1].

Anesthesiologists should carefully assess each patient’s functional status. If a patient remains de-conditioned following COVID illness, it may be prudent to defer non-urgent procedures. Pre-operative exercise programs, shown to reduce complications in frail patients [10], should be considered.

## 7. Conclusion

Even beyond the acute crises of the COVID-19 pandemic, millions of people worldwide remain at risk for long-term sequelae of SARS-CoV-2 infection. Anesthesiologists must be prepared to recognize and safely manage these residual effects of COVID-19 infection.

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## References

- [1] Huang C, Huang L, Wang Y, et al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *The Lancet*.
- [2] Davido B, Seang S, Tubiana R, de Truchis P. Post-COVID-19 chronic symptoms: a postinfectious entity? *Clin Microbiol Infect* 2020;26(11):1448–9.
- [3] Aghagholi G, Gallo Marin B, Katchur NJ, Chaves-Sell F, Asaad WF, Murphy SA. Neurological involvement in COVID-19 and potential mechanisms: a review. *Neurocrit Care* 2020;1–10. <https://doi.org/10.1007/s12028-020-01049-4>.
- [4] Mitrani RD, Dabas N, Goldberger JJ. COVID-19 cardiac injury: implications for long-term surveillance and outcomes in survivors. *Heart Rhythm* 2020;17(11):1984–90.
- [5] Huang L, Zhao P, Tang D, et al. Cardiac involvement in patients recovered from COVID-2019 identified using magnetic resonance imaging. *JACC Cardiovasc Imaging* 2020;13(11):2330–9.
- [6] Torres-Castro R, Vasconcello-Castillo L, Alsina-Restoy X, et al. Respiratory function in patients post-infection by COVID-19: a systematic review and meta-analysis. *Pulmonology*. 2020. <https://doi.org/10.1016/j.pulmoe.2020.10.013>. S2531-0437 (20)30245-2.
- [7] Hull JH, Lloyd JK, Cooper BG. Lung function testing in the COVID-19 endemic. *Lancet Respir Med* 2020;8(7):666–7.
- [8] Nadim MK, Forni LG, Mehta RL, et al. COVID-19-associated acute kidney injury: consensus report of the 25th acute disease quality initiative (ADQI) workgroup. *Nat Rev Nephrol* 2020;16(12):747–64.
- [9] Fan BE, Umapathi T, Chua K, et al. Delayed catastrophic thrombotic events in young and asymptomatic post COVID-19 patients. *J Thromb Thrombolysis* 2020: 1–7.
- [10] Howard R, Yin YS, McCandless L, Wang S, Englesbe M, Machado-Aranda D. Taking control of your surgery: impact of a Prehabilitation program on major abdominal surgery. *J Am Coll Surg* 2019;228(1):72–80.

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