

## **Evaluation of the Post-COVID Patient Prior to Elective Plastic Surgery: Developing an Evidence-Based Framework**

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Disclosures: The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Funding: The authors received no financial support for the research, authorship, and publication of this article.

Level of Evidence: 4 (Risk)

## **Abstract**

Preoperative assessment of a potential surgical patient has long been a cornerstone of patient safety. As more patients get, and recover from, COVID-19, plastic surgeons will be faced with the challenge of evaluating the health status and operative risk of convalescent COVID patients who now desire elective surgery. A significant fraction of these patients, however, can have new or persistent health issues as a result of COVID-19, which can affect surgical safety. This paper briefly examines the current relevant literature regarding the post-COVID patient, reviews the waiting period for adequate recovery, and suggests an evidence-based framework for preoperative assessment, based on the severity of the prior COVID-19 episode, ongoing symptoms, and basic screening tests.

Accepted Manuscript

The goal of this paper was to attempt to synthesize a sensible framework for the pre-surgical evaluation of any patient undergoing general anesthesia following a prior recent COVID-19 infection. This is based on a current review of evidence in the English-language literature as of July 2021, as there are no plastic surgery-specific guidelines available at this time. Despite the large amount of published material on acute COVID-19 and its complications, relatively little has been published about the risk assessment and preoperative evaluation of a previously COVID-positive patient prior to elective surgery, following the resolution of the acute phase of their illness. As more patients get and recover from COVID-19, plastic surgeons will be seeing an increased number of these patients who desire plastic surgery. How should a plastic surgeon evaluate a patient who presents after a mild case of COVID-19 treated as an outpatient, who is now seemingly recovered? How should the surgeon evaluate someone who was hospitalized 2 months ago with COVID-associated pneumonia, but now wants a major procedure, like a facelift or abdominoplasty?

### **Current Recommendations from the American Society of Anesthesiologists (ASA) and Anesthesia Patient Safety Foundation (APSF)**

Based on guidelines as of August 2021, the ASA and APSF support <sup>1,2</sup>:

1. Screening all patients for symptoms of COVID-19 prior to their procedure. Symptomatic patients should be referred for additional evaluation.
2. PCR testing for COVID prior to non-emergent surgery for all patients, regardless of vaccination status. This should be performed 3 or fewer days prior to the procedure.
3. Delay of surgery for patients with a positive test for SARS-CoV2.

They have not, however, published guidelines on what kind of evaluation a patient with a prior COVID-19 episode should have, prior to an elective procedure.

### ***Follow-Up Studies on Post-COVID Survivors***

There are now a number of published articles that document the post-discharge course of non-surgical patients after an acute COVID-19 infection. These findings can logically influence our follow-up and testing protocols prior to a subsequent surgery, as we better understand the natural history and course of this multi-system disease. Prolonged symptomatology in patients who were severe enough to require hospital admission seems to be the rule, rather than the exception.

For example, at 4-6 weeks post discharge, 40% of former COVID-19 inpatients still had identifiable cardiopulmonary causes of dyspnea, including: abnormal lung parenchyma (32%), pulmonary embolism (2% patients) and cardiac complications (6% pts).<sup>3</sup> ICU patients were 2.8 times more likely to have these symptoms than those cared for on the inpatient ward. In the patients with moderate-to-severe COVID-19 in who were one to two months from symptoms onset,<sup>4</sup> complaints of dyspnea were still a concern for over one-third of patients at day 30.

By 8-12 weeks after admission, approximately one third of survivors with moderate or severe COVID still had abnormal chest X-ray, spirometry, exercise desaturation and abnormal blood chemistries.<sup>3</sup> In those with “mild” prior cases of COVID-19, follow-up chest X-rays were typically read as “normal” and spirometry was also normal, even though approximately 60% of the “mild” group still reported ongoing symptoms at their 12-week follow-up appointment.<sup>5</sup> Other studies of moderate to severe COVID survivors at this same time period demonstrated abnormal MRIs of the lungs in 60%, heart in 26%, kidneys in 29% and liver in 10%, and significant decreases in FVC, FEV1 and cardiopulmonary exercise test parameters in hospitalized COVID-19 survivors.<sup>6</sup> Chest CT, in another study, showed abnormalities in 96.1%.<sup>7</sup>

At 3 months after COVID-19, 42% of hospitalized COVID survivors had impaired lung diffusion capacity, 22% had diminished exercise tolerance (<80% of predicted) on the six-minute walk test, and 36% had cognitive impairments.<sup>8</sup> In the patients with prior “mild” COVID-19, PFT’s were largely normal, and only 12% had diminished exercise capacity on the six-minute walk test, and only 7% had residual changes on their chest X-ray. At four–six months post hospitalization for moderate to severe COVID-19, persistent fatigue, cognitive dysfunction, and dyspnea remained common complaints. Anxiety, depression and posttraumatic symptoms were also frequent among former ICU patients.<sup>9,10</sup>

A comprehensive medical work-up is now suggested for all COVID-19 survivors with severe or critical level at 4-6 weeks after discharge, with a battery of tests.<sup>11,12</sup> Approximately 10% of U.S. COVID patients are re-hospitalized within two months, usually to the same hospital.

## System Review

Recall that a significant number of patients can have new or ongoing symptoms after COVID-19, even in those who had mild or asymptomatic disease.<sup>13</sup> Health effects, including pulmonary fibrosis, myocarditis, hepatic dysfunction, renal failure, neurologic disease and thromboembolic issues can persist after the acute phase of the illness.<sup>14</sup> Additionally, long hospital stays, especially in the ICU, can lead to de-conditioning and frailty. While many of these changes are associated with moderate to severe COVID-19, even those with mild COVID-19 treated as an outpatient can also experience symptoms for several months after their acute illness. An online, self-reported survey, found that less than 1% of patients reported being completely symptom free by 11-12 weeks following their onset of symptoms.<sup>6</sup>

## Cardiopulmonary

One-third of patients with acute COVID-19, especially patients with prior cardiac disease, may have signs and symptoms of acute cardiac injury, myocarditis-associated cardiac dysfunction or dysrhythmias.<sup>15</sup> EKG changes are common in patients with COVID pneumonia, including ST-T segment changes, left ventricular hypertrophy, atria fibrillation, tachycardia, bradycardias, and changes associated with pericarditis.<sup>15-17</sup> In critically ill patients, 90% of patients demonstrate at least one EKG abnormality.<sup>18</sup> Of note, EKG changes do not always progress simultaneously with the pulmonary changes of COVID, and may have a late onset, averaging 30 days after initial symptom onset.<sup>17</sup>

The question of whether COVID-associated cardiac abnormalities persist after hospital discharge still seems open to debate. In patients with myocardial injury shown by elevated troponin levels, abnormal echocardiogram findings were noted during low-level exercise, even 6 months after hospitalization.<sup>19</sup> Patients who did not have elevated troponin levels or other indicators of prior myocardial injury did not show echocardiographic changes. Abnormal cardiac MRI findings were also noted in the majority of hospitalized patients 2-3 months after discharge.<sup>20</sup> These changes may be *independent of the severity and overall course of the acute illness*. COVID survivors also have higher rates of cardiac comorbidities, including hypertension, acute coronary disease, and heart failure, with increasing prevalence with increased disease severity.<sup>21</sup>

Sonnweber and associates published a multicenter follow-up study of cardiopulmonary recovery at 60 and 100 days after COVID-19 onset.<sup>22</sup> On the positive side, improvement of symptoms and resolution of CT abnormalities were seen over time. CT

severity scores correlated with the degree of the initial illness (mild, moderate, severe or critical), with mild and moderate categories returning to nearly baseline by 100 days. Other authors note that CT abnormalities may not correspond with clinical findings.<sup>23, 24</sup> While CT chest is useful for follow-up of lung lesions in patients with prior abnormalities, it is not recommended as a pre-operative testing method for the asymptomatic patient.<sup>25</sup>

### **Venous Thromboembolism**

VTE is a common complication of moderate to severe COVID-19. ICU patients, especially those on invasive ventilation, were significantly more likely to have VTE's, with a rate of 23.9% within 90 days of admission.<sup>26</sup> Following discharge from hospital, 2.6% of patients with prior moderate or severe COVID-19 had a symptomatic VTE in the first 6 weeks post-discharge. Clinicians need to remain alert to this possibility in the post-COVID patient.

### **Liver**

Hepatic dysfunction during acute COVID-19 is also common. Forty percent of patients still had LFT abnormalities at discharge, particularly the transaminases (ALT, AST).<sup>27</sup> These improve over the first few months post-discharge, dropping to 10% having abnormal results by that time.<sup>28</sup> Thus, it is not unreasonable to follow-up on LFT's in the early post-COVID period.

### **Minimum Wait Time After COVID-19 Prior to Surgery**

Recent evidence strongly suggests that surgical risks decrease with time after a resolved acute COVID infection. Currently, there is some variability in the recommendations for the minimum wait time after acute COVID-19, particularly as severity increases. The multidisciplinary consensus statement<sup>29</sup> from multiple leading surgical and anesthesiology associations in the UK regarding the timing of surgery after COVID-19 is well worth reviewing, as is the original study it was based on.<sup>30</sup> For patients with an *active* SARS-CoV-2 infection, 30-day mortality in elective (planned) surgery is 19.1% and 26.0% for emergency surgery patients of all types. This rate is consistent with findings of other meta-analyses.<sup>31</sup>

At seven weeks after COVID-19 diagnosis, the risk of mortality decreased to a level similar to non-infected controls. This timing was remarkably consistent: the same 7 week wait period was showed a return to baseline levels of risk across subgroups of age, ASA physical status, for elective vs. emergency procedures, and minor versus major procedures.<sup>30</sup> Patients with persistent symptoms, however, remained at an increased risk of postoperative

morbidity and mortality, and require a longer wait time.<sup>29, 30</sup> Additional factors to consider include whether the patient has received high-dose steroids or other immune-suppressant medication, use of anticoagulation, co-morbid diseases such as diabetes and obesity, and the presence of other complications of COVID.

One drawback of this study, which currently represents some of the most granular data existing on surgical risk and timing of surgery, is that the patients were not stratified by the severity of their prior COVID-19 episode. The 7-week figure, in our group's opinion, is suitable for asymptomatic or mild cases of COVID-19 who now have complete resolution of symptoms, a full return of their pre-COVID level of functioning, and no abnormalities on their screening O<sub>2</sub> saturation, labs or EKG. Similar data regarding "long COVID" syndromes, even after mild illness, is not yet available.

Kovoor and associates review a number of international expert statements and opinions about the mandatory wait time prior to surgery, and suggest that 8-12 weeks delay after lab confirmation of SARS-CoV2 infection is appropriate for "major surgery", and that a delay "at least 4 weeks" for minor surgery is probably safe. They do not, however, define these terms in their paper.<sup>32</sup>

Conversely, the ASA and APSF Joint Statement on Elective Surgery and Anesthesia for Patients after COVID-19 Infection<sup>33</sup> from March 2021 has shorter wait times. They suggest:

- Four weeks for an asymptomatic patient or recovery from only mild, non-respiratory symptoms.
- Six weeks for a symptomatic patient (e.g., cough, dyspnea) who did not require hospitalization.
- Eight to 10 weeks for a symptomatic patient who is diabetic, immunocompromised, or hospitalized.
- Twelve weeks for a patient who was admitted to an intensive care unit due to COVID-19 infection

▾ These recommendations were formed by expert opinion earlier in the pandemic, and have not yet been updated in light of more current data. The ASA/APSF admit these numbers "should not be considered definitive", and that risk assessment should be individualized. Patients who have recovered from COVID-19, but still have ongoing symptoms, should receive "a more thorough cardiopulmonary evaluation" in advance of surgery.

Other authors disagree with this time frame, preferring a longer recovery for patients with more severe episodes of COVID-19. Strumilene and associates state, "two months are

not sufficient for full regression of symptoms” following moderate, severe or critical COVID-19 pneumonia.<sup>34</sup> Sonnweber et al found persistent pulmonary symptoms, abnormal PFTs and CT abnormalities even at more than 100 days following the diagnosis of moderate to severe COVID-19.<sup>22</sup> Markarious and associates point out that coagulopathy after severe COVID-19 may take approximately 90 days to normalize, and that pulmonary diffusion capacity and radiographic changes persist in approximately half of all patients with severe COVID for 6 months.<sup>35</sup> Thus, a slow and cautious approach to a post-COVID patient with moderate, severe or critical disease is suggested, with a low threshold for additional testing and consultations.

Looking at COVID-19 survivors who underwent surgery, a study of 112 case-matched patients who had prior mild to moderate COVID-19 that subsequently needed a cancer-related procedure at the MD Anderson Cancer Center was reviewed for outcomes.<sup>36</sup> Average wait time between positive tests and surgery was approximately 6 weeks for asymptomatic patients, and approximately 9 weeks for symptomatic patients. With this mandatory delay period, the authors found no difference in the adverse postoperative outcome rates. These time periods coincide with the recommended surgical delay of the ASA/APSF. Curiously, the authors then based their final recommendations for a “minimum of a 20 day wait time” after a positive COVID test on the patient with the shortest interval wait time in their study group, rather than the mean wait times mentioned above.<sup>36</sup>

### **Evidence-Based Framework for Pre-Surgical Evaluation, Based on Severity of Prior COVID Episode, Symptoms, and Screening Tests**

Based on the preceding review, it seems apparent that the severity of the prior COVID episode makes a significant difference in the likely risk for surgery. COVID-19 severity was therefore categorized using a previously published method,<sup>29</sup> and laboratory tests, imaging and the use of additional consultations were then integrated into this framework, based on our literature review.

- Mild: treated as an outpatient
- Medium: requiring hospital admission and/or oxygen use, but not ICU admission or mechanical ventilation
- Severe: requiring ICU admission and/or mechanical ventilation

The suggested preoperative work-up chart is shown in Table 1, for procedures involving general anesthesia or deep IV sedation. These are “suggestions only” as of July 2021 and are



designed to be a helpful guide for surgeons. This is not to be considered as a specific “standard of care”. While it may seem obvious, it is worth emphasizing that there is *never* a rush to perform elective aesthetic surgery, particularly in a patient who recently survived a major medical event. It is expected that the reasons for a survivor of severe or critical-level COVID-19 to have an elective aesthetic procedure would be rare indeed, while aesthetic procedures for those with a mild prior case could be quite reasonable, once an appropriate medical work-up is completed and the minimum suggested wait time has passed. As always, our duty to the patient is to put their safety first. Local guidelines of your hospital or ambulatory surgical facility must also be followed. Awareness should be heightened when local prevalence of the disease is high.

It is still unknown whether recovery from COVID-19 is different rather the recovery from other severe illnesses. It may well be prudent to consider recovery from an episode of severe COVID-19 much like we do the recovery from an episode of sepsis due to other infections.<sup>37</sup> Patients who have recovered from a severe episode of sepsis, for example, are believed to have an increased risk of mortality for at least 2 years thereafter.

As always, a comprehensive patient history determines the details of the evaluation, focusing on the specifics of the patient’s acute COVID-19 illness and treatment, and looking for ongoing signs and symptoms of potential COVID-associated complications or persistent disease-related issues. A careful cardiopulmonary physical examination and a functional capacity assessment of whether the patient has truly returned to their pre-COVID-19 level of function should be performed.<sup>6</sup> Review of the hospital course, lab results and interventions gives a sense of the severity of the patient’s case. Hospital discharge summaries and pre-COVID medical records and test results can be very helpful to sort out changes in the patient’s status. An introductory overview of assessment and testing in the non-surgical patient is available from the CDC.<sup>38</sup> Some university centers and large hospital centers are beginning to develop outpatient clinics for post-COVID care and evaluation; these should be utilized where available, as taking a detailed history of the COVID-illness could be complex and time-consuming in the more severe cases.

### ***Oxygen Saturation***

Room air O<sub>2</sub> saturation is measured with a peripheral oximeter in all post-COVID patients.<sup>14, 39,40</sup> Further workup is indicated for a SpO<sub>2</sub><94% at rest, or for desaturation with activity, particularly in a patient without known COPD. Decreased SpO<sub>2</sub> may also indicate chronicity of COVID disease and is worsened by the severity of the prior episode.<sup>40</sup>

### **Review of COVID Symptoms and Assessment of Functional Capacity**

The clinician should ask questions regarding common post-COVID symptoms— in particular SOB, SOBOE, fatigue, headache, chest-tightness, chest pain, palpitations, and “brain fog”. Dyspnea and significant fatigue are reported by the majority of patients following moderate to severe COVID.<sup>8, 38</sup> Patients with persistent or recurring symptoms, even after a reportedly “mild case” of COVID, require further evaluation.

Functional capacity is an important part of risk assessment prior to major surgery, and is commonly used by anesthesiologists.<sup>41</sup> Questions derived from the MET (metabolic equivalent) scale can be used to conveniently gauge exertion levels.<sup>42</sup> These include the ability to walk briskly, the ability to climb two flights of stairs, and to perform other common activities of daily living or recreation. For asymptomatic patients after mild COVID-19, it may be enough to ask “Can you do everything you did prior to COVID, without restriction?” Alternatively, the ECOG (Eastern Co-operative Oncology Group) Performance Status can be used<sup>43</sup>, with patients who score a 0 (normal) or 1 (ambulatory, but not able to perform strenuous physical activity) not requiring further evaluation.

### **Six Minute Walk Test**

A standardized “6 minute walk test” (6MWT) with pre/post O<sub>2</sub> saturation measurements has been shown to be a reliable screening method when there are concerns about exercise tolerance and functional capacity, and is predictive for postoperative pulmonary complications after general anesthesia.<sup>44</sup> It is a timed test of how *far* a patient can walk in six minutes, using two cones placed 10 meters apart in a level corridor.<sup>45</sup>

The 6MWT is suggested as a screening test for moderate or severe COVID survivors, and any *symptomatic* patient after a “mild” course. Approximately one-quarter of hospitalized COVID survivors, especially those with severe disease, had a reduced physical capacity in the 6MWT, and 9% showed desaturation.<sup>40, 46</sup> Reduced distances on the 6MWT are

associated with more severe post-COVID disease and impaired lung diffusion capacity (DLCO).<sup>8,9,38,46,47</sup> Patients with a reduced 6MWT distance require additional consultations.

### **Lab Tests**

Guidelines from your hospital or ambulatory surgical facility for lab tests, EKG's and preoperative evaluation should, at minimum, be followed, recognizing that, at the present time, these requirements may not yet be reflective of the latest data for the post-COVID-19 patient.

We recommend that a CBC with differential, and Complete Metabolic Profile (CMP) be obtained for all potential surgical patients who have had a prior COVID-19 episode, regardless of age.<sup>14, 48, 49</sup> Further lab testing – such as a coagulation panel, D-dimer and an inflammatory marker panel - is based on the presence of persistent symptoms, the results of screening tests, and the magnitude of the proposed surgical procedure.

### **Screening 12 Lead EKG**

Although surgeons are not in the habit of routinely obtaining a 12-lead EKG in younger patients, cardiac changes are common post-COVID and an EKG is suggested for all post-COVID-19 patients, even ones with a milder course.<sup>14, 49</sup> Look for arrhythmias and new ST changes, and specifically compare to old EKGs, if available, to spot subtle changes.

### **Chest X-Ray**

While other authors<sup>14, 43</sup> have recommended preoperative chest X-rays for all surgical patients, we do not feel they are indicated in completely asymptomatic patients with a mild prior case of COVID -19, with a normal O<sub>2</sub> saturation and normal physical exam. A chest X-ray is obtained if any pulmonary symptoms are still present, an abnormality is noted on physical exam, or the patient carries a prior diagnosis of documented COVID pneumonia and/or prior abnormal chest imaging. Abnormal findings should prompt additional investigations. Of note, the British Thoracic Society recommends a routine follow-up chest x-ray for all patients with prior moderate severity COVID, at 12 weeks after hospital discharge.<sup>50</sup>

While some authors prefer the use of a high-resolution chest CT (HRCT) for follow-up, we felt that additional chest imaging should be left to the discretion of a pulmonary consultant. Common findings on HRCT in acute COVID-19 include: ground glass opacities, consolidation, and a combination pattern of ground glass opacities with superimposed septal

thickening, known as “crazy paving”; these gradually seem to lessen with time, as the patient enters a post-acute “absorption phase”, which may be protracted.<sup>23, 24,40,46,51</sup>

### **Coagulation Panel and D-Dimer Test**

Thrombotic and thromboembolic phenomenon are common during acute COVID, with a 2-6-fold increase.<sup>52</sup> The hypercoagulable state may persist after resolution of the acute illness, although the exact time period remains unknown. Additionally, abnormal D-dimer levels and Prothrombin results have correlated with more severe disease patterns and abnormal DLCO in non-critical COVID survivors, even in the absence of respiratory symptoms.<sup>53</sup>

While some authors have recommended a coagulation panel for every patient prior to every procedure,<sup>14, 54</sup> we feel it is acceptable to obtain a coagulation panel and D-dimer for patients previously hospitalized with COVID-19 prior to a major procedure under general anesthesia. Sustained elevations of D-dimer may last up to 2 months after COVID-19 even after the normalization of other coagulation parameters in 25.3% of patients.<sup>53</sup>

We also suggest obtaining a D-dimer test prior to VTE-prone procedures even in “mild” cases of prior COVID-19, or as needed to investigate ongoing symptomatology suggestive of a VTE. A D-dimer more than twice the upper limit of normal (ULN) should prompt additional evaluation. Some authors<sup>14</sup> have also recommended checking fibrinogen levels prior to major procedures, but this suggestion has not received widespread support<sup>48</sup>, and we do not recommend routine fibrinogen testing at this time.

### ***Inflammatory Markers***

Elevations of inflammatory markers are indicators of poor prognosis in acute COVID-19, and are also associated with post-acute symptoms of COVID, such as cough, low-grade fever and fatigue, and may be useful diagnostic markers for a chronic “long-COVID” state.<sup>50</sup> They are commonly elevated at the time of hospital discharge for those with moderate or severe cases.<sup>54</sup> Therefore, we recommend these tests for previously hospitalized patients, and for those who have ongoing symptoms suggestive of “long-COVID”.

Of the multiple inflammatory marker serum tests that are available, the C-Reactive Protein (CRP) and serum ferritin, along with the D-dimer, appear to be the most commonly used. A Hematology consult is obtained if the values of CRP exceed five times the upper limit of normal, or the serum ferritin exceeds 1.5 times the upper limit of normal.

### **Additional Consultations**

Since cardiac abnormalities are also common after COVID-19 even in young, fit individuals, preoperative Cardiology consultations are suggested liberally for hospitalized COVID survivors. They should be considered prior to any major procedure under general anesthesia or deep IV sedation. Resting EKG abnormalities, cardiac symptoms or poor exercise tolerance, and elevated troponin levels during hospitalization, even in those with “mild COVID episodes” should receive a further work-up. Echocardiography, cardiac MR or other cardiac testing would be ordered at the discretion of the Cardiology consultant.

Pulmonary consultation is suggested for survivors of both moderate and severe COVID-19, and for those with “mild COVID” who have persistent symptoms, abnormalities on physical examination or a reduced functional capacity assessment. Pulmonary function tests and arterial blood gases are not ordered routinely, as these are not used in routine evaluation of non-thoracic surgical procedures but would be obtained at the discretion of the Pulmonologist, along with HRCT or MRI of the chest.<sup>14</sup>

Hematology consultation is suggested for previously hospitalized patients, especially for major and/or VTE prone procedures. They are also requested for patients with prior VTE's, use of recent anticoagulation, and those with abnormalities in their inflammatory marker panel, coagulation panel or CBC. In particular, advice about VTE risk and the type, dose and duration of VTE prophylaxis for the upcoming surgery can be helpful in these patients, as this topic is complex and evolving rapidly.

Psychiatry or Neurology consults are obtained as needed for mood disorders, anxiety, depression or cognitive dysfunction. Sleep disorders are common following moderate-severe COVID-19. In patients admitted to the ICU, 23% report anxiety, 18% have depression, and 7% show signs of PTSD.<sup>55</sup>

### ***Use of Local and Regional Anesthesia***

Use of local anesthesia alone avoids the physiologic stress that accompanies a general anesthetic. This would also seem to be a safe approach to a minor procedure in a COVID-survivor. A large patient series of plastic surgery procedures, mostly skin cancer excisions and minor hand cases, used primarily local anesthesia to successfully perform cases early in the COVID-19 pandemic.<sup>56</sup> Currently, there is little data on which to base pre-operative testing recommendations for a “local-only” case for the post-COVID patient.

Regional anesthesia is another useful option; particularly if long-acting local anesthetic agents are used.<sup>57-59</sup> Use of ultrasound guidance may lessen the chance of a failed block. Hotta<sup>58</sup> discusses the use of regional and spinal anesthesia but raises the concern about an unplanned conversion to general anesthesia during surgery under local or regional anesthesia, which would certainly not be optimal. Nerve blocks are avoided in the same sensory distribution for patients with pre-existing neuropathy.<sup>58</sup> Antithrombotic agents, anticoagulants or thrombocytopenia would be contraindications to the use of injection-based techniques. Recommendations regarding regional anesthesia are not significantly different than they would be for other respiratory diseases and are not COVID-specific.<sup>29</sup>

Currently, there is very little in the literature about the use of IV sedation in a patient with prior COVID. "IV sedation" can be a wide continuum, varying from minimal anxiety reduction to a near general anesthesia-like state. For that reason, consideration should be given to using the guidelines that apply to general anesthesia for moderate to deep IV sedation. The usual concerns about an unplanned, emergent conversion to general anesthesia, hypoxia or the loss of airway control also exist in this situation as well. Although there was a report discussing the use of total intravenous anesthesia in selected cases in an ambulatory otolaryngology service, patient selection data and specific techniques were not detailed.<sup>60</sup>

### ***Recent Administration of COVID Vaccine***

While a detailed discussion of the entirety of COVID vaccination policies is well beyond the scope of this paper, vaccination several weeks before surgery will reduce the possibility of subsequent COVID infection to the patient themselves and might lessen the possibility of spread to other patients and staff.<sup>29</sup> Currently, the American Society of Anesthesiologists recommend a 2-week period after the final dose of COVID vaccines, prior to surgery.<sup>61</sup> If the patient feels unwell after vaccination, it may be prudent to postpone surgery until the patient recovers fully. Rarely, vaccine-induced thrombotic thrombocytopenia (VITT) has been reported in the first four weeks after the AstraZeneca (Cambridge, UK) and Johnson & Johnson (New Brunswick, NJ, USA) COVID-19 vaccines. The incidence of VITT seems to be approximately 2-3 per million vaccines given overall, but increased in women between ages 20 and 55.<sup>62</sup>

### **Other Published Protocols**

There have been a few other papers with that have discussed pre-operative testing of COVID survivors prior to surgery. Early in the pandemic, Kaye et al described an algorithm for risk stratification of elective, non-emergent patients.<sup>48</sup> At that time, their concern was more about not operating on a COVID-positive or other high-risk aesthetic patients by using repeated COVID testing, although they did give some recommendations about pre-operative testing. They did not specifically focus on the post-COVID patient, and much of the data we now have on the recommended delay time for surgery and the natural history of the post-COVID patient was not yet available.

Bui and associates<sup>14</sup> developed a protocol for preoperative evaluation of patients with prior COVID, prior to the guidelines published by the ASA / APSF or the Royal College of Anaesthetists and Royal College of Surgeons of England. In the absence of specific evidence-based guidelines, they drew inferences from the recovery time after myocardial infarction, stroke, and upper respiratory infections, and decided on a minimum recovery time of 4 weeks for asymptomatic COVID patients, and 6-8 weeks for symptomatic COVID survivors. They did not stratify the delay period based on the severity of symptomatic illness. Their lab testing routine for all procedures under general anesthesia was more test-intensive than ours, and included the routine use of CBC, CMP, PTT, D-dimer, fibrinogen, NT-pro-BNP and routine chest x-ray, even for previously asymptomatic or mild patients. Symptomatic COVID patients also received testing for inflammatory markers and consideration for echocardiogram. While they had applied their protocol to 40 patients, they did not report on the testing outcomes.

An online survey of anesthesiologists also reviewed the evaluation of the post-COVID patient, and tabulated responses to questions about pre-operative testing, based on categories like the patient's current degree of hypoxia.<sup>63</sup> They did not make specific recommendations or present a testing protocol as we have here, but were in full agreement with the need to perform a comprehensive preoperative evaluation for all COVID-19 recovered patients, especially those with any residual symptoms.

During the final editing of this paper, the Indian Society of Anesthesiologists published a comprehensive paper on the post-COVID surgical patient.<sup>49</sup> There is good general agreement with our testing rationale, but their approach to pre-op testing is not based on the severity of the prior COVID-episode, but rather on the patient's current ASA physical status category and the magnitude of the proposed procedure. The authors only included

patients with asymptomatic or mild prior COVID-19 disease. They did not make recommendations for patients who had required hospitalization for their COVID, nor discuss the indications for additional consultations.

### **Conclusion**

Evaluation of the post-COVID patient prior to an elective surgical procedure is a complex and multi-factorial issue, even for young healthy patients who did not require hospitalization during their acute episode of COVID-19. There is not a “one size fits all” protocol. Careful evaluation of the patient is suggested, looking at commonly known complications of COVID-19 in multiple organ systems, and factoring the severity of the disease course, the treatment in hospital, and the magnitude of the proposed surgery into the risk-benefit equation. This document and its protocol simply represent a starting place for discussion. As the numbers of post-COVID patients increase, the situation where seemingly recovered COVID-19 survivors desire elective surgery will only become more commonplace. The suggestions in this document do not constitute formal requirements or standards of care and will likely evolve as new data emerges.



## **Acknowledgements**

The authors would like to thank Dr Steven Teitelbaum for helpful comments and discussions during an early draft of this paper.

Accepted Manuscript

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**Table 1.** Suggested Preoperative Evaluation, Based on Severity of Prior COVID-19 Episode

Test/severity of prior COVID-19	Mild (outpatient tx. only)	Moderate (hospitalized; non-ICU)	Severe (ICU or intubated)
Mandatory wait time for elective procedures after COVID-19	Minimum 6-7 weeks, if asymptomatic and full return to pre-COVID functional status	Controversial – At least 2-3 months, possibly longer (see text)	Controversial (see text)
Check room air O <sub>2</sub> saturation. Refer for sPO <sub>2</sub> < 94%	Yes	Yes	Yes
Detailed questioning regarding post-COVID symptoms and possible complications, and assessment of functional capacity (see text)	Yes	Yes	Yes
Standardized 6-minute walk test	6-minute walk test if symptomatic, esp. symptoms of severe fatigue, SOB or SOBOE, or low sPO <sub>2</sub>	Yes	Yes
12 lead EKG	Strongly consider for all patients. Obtain for any cardiac symptoms (see text) history or age requirements.	Yes	Yes
CXR	No, if completely asymptomatic and has normal pulmonary exam, O <sub>2</sub> sat and exercise tolerance. Consider for major procedures under GA.	Yes. Some authors prefer HRCT for follow-up of prior lung changes.	Yes Some authors prefer HRCT for follow-up of prior lung changes.
Coagulation panel, D-dimer	Consider for major procedures. Order for evaluation of ongoing cough, fatigue, low-grade fever or suspicion of VTE.	Yes	Yes

Inflammatory markers (CRP, ESR, Ferritin)	Not routine. Order for evaluation of ongoing cough, fatigue, low-grade fever, or VTE-prone procedures.	Yes	Yes
Cardiology consult	If screening EKG positive (ST changes, bradycardias, arrhythmias, etc.), or pt. with symptoms of chest pain, SOB, palpitations, CHF or poor functional capacity	Yes. As for “mild disease”, and for any major procedure under GA.	Yes
Pulmonary Consult	If patient has persistent pulmonary symptoms, abnormal chest exam findings, low O2 sat, poor functional capacity or history of abnormal CXR.	Yes. As for “mild”, plus follow-up of pulmonary symptoms and imaging abnormalities from hospital course, and for any major procedure under GA.	Yes
Hematology Consult	If CBC, coagulation panel, or inflammatory markers are abnormal (or were within past 30 days)	As for “mild”, plus follow up of relevant lab abnormalities from prior hospital course, assessment of current VTE risk from planned procedure. Obtain for any patient with prior VTE or complications of anticoagulation.	Yes
Neurology or Psych Consult	If clinically indicated for mood, anxiety or other cognitive issues	If clinically indicated for mood, anxiety or other cognitive issues	Consider for post-ICU syndromes, and mood, anxiety, cognitive issues.