

# Collective Review Anesthesia for Patients after COVID-19 Infection

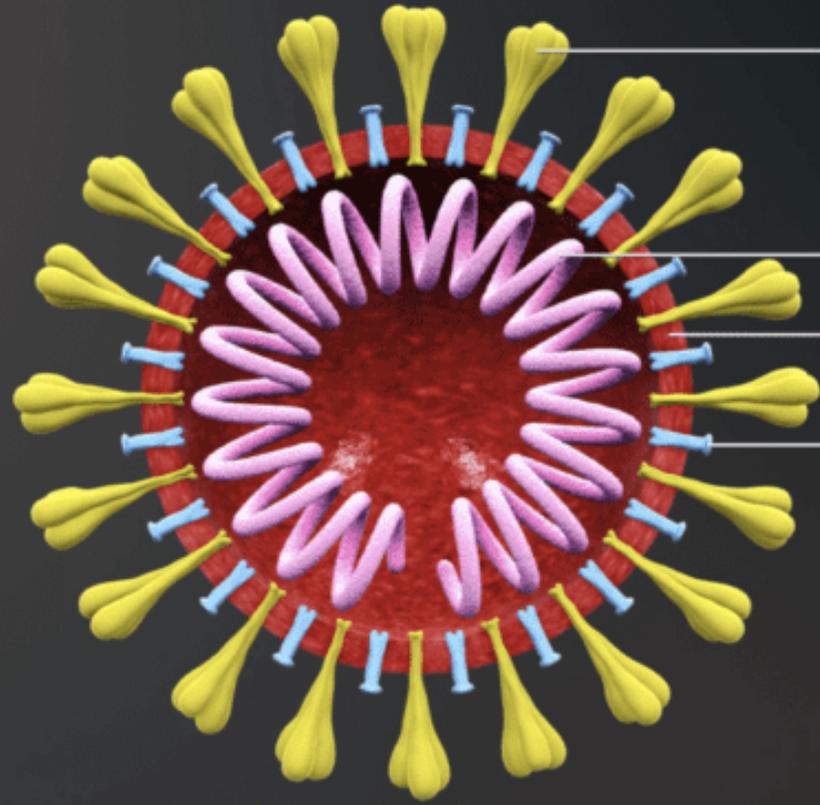
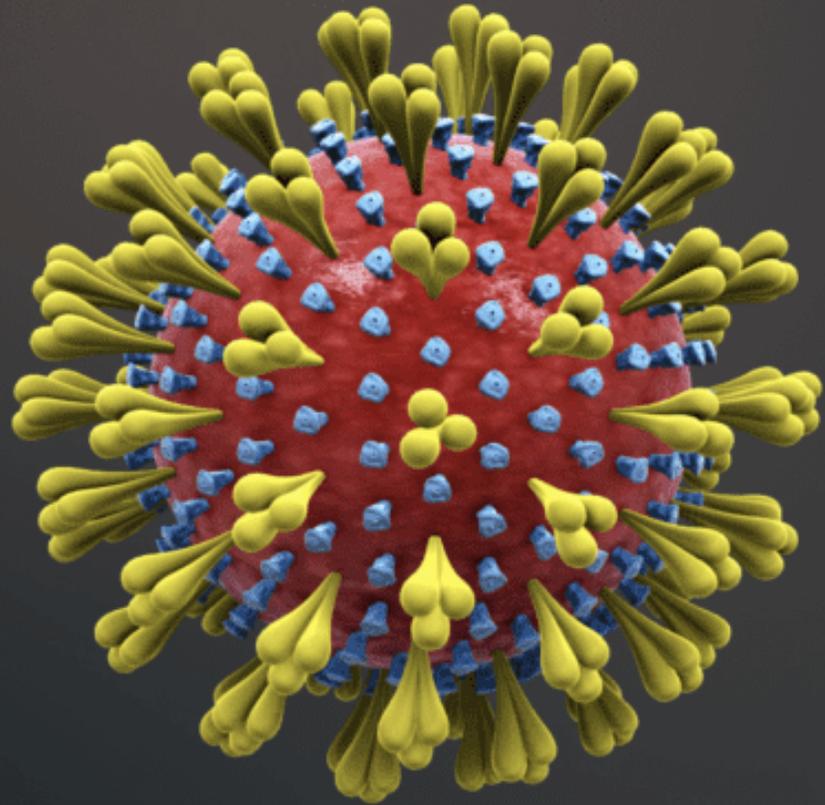
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# Outlines

- ▶ COVID-19
- ▶ Post COVID-19 infection
- ▶ Anesthesia in post COVID-19
  - ▶ Timing before surgery
  - ▶ Anesthetic considerations
  - ▶ Preoperative evaluation and investigations
  - ▶ Perioperative management
  - ▶ Postoperative care

# COVID-19

- ▶ SARS-CoV-2
- ▶ Betacoronavirus in the family of Coronaviridae of the order Nidovirales
- ▶ The time between infection and first symptoms (incubation period) ranges from 1 to 14 days, with an average of 5 to 6 days.



Spike Glycoprotein (S)

RNA and N protein

Envelope

Hemagglutinin-esterase dimer (HE)

# Symptom

- Fever or chills
- Cough
- Shortness of breath or difficulty breathing
- Fatigue
- Muscle or body aches
- Headache
- New loss of taste or smell
- Sore throat
- Congestion or runny nose
- Nausea or vomiting
- Diarrhea

# Severity

- ▶ Patients infected with SARS-CoV-2 confirmed by RT-PCR testing
- ▶ The National Institutes of Health has recently updated the categories of SARS-CoV-2 infection
  - ▶ Asymptomatic or Presymptomatic Infection
  - ▶ Mild Illness.
  - ▶ Moderate Illness
  - ▶ Severe Illness
  - ▶ Critical Illness
  - ▶ Severely immunocompromised patients, whether suffering from asymptomatic or symptomatic COVID-19, are considered separately

# Severity

## Asymptomatic

- No clinical manifestation

## Mild

- Mild clinical manifestation
- No change in imaging

## Moderate

- Fever
- Respiratory symptom
- Pneumonia on CXR or CT scan

# Severity

## Severe

- Meet any criteria of these following
  - Respiratory distress RR>30/min
  - Oxygen saturation <93 % at rest
  - PaO<sub>2</sub>/FiO<sub>2</sub> <300 mmHg

## Critically severe

- Respiratory failure needs mechanical ventilation
- Shock
- Combined with other organ failure

# Post COVID-19 infection

## American Society of Anesthesiologists and Anesthesia Patient Safety Foundation Joint Statement on Elective Surgery/Procedures and Anesthesia for Patients after COVID-19 Infection

Published: March 9, 2021

Last updated: February 22, 2022

Since hospitals are able to continue to perform elective surgeries while the COVID-19 pandemic continues, determining the optimal timing of procedures for patients who have recovered from COVID-19 infection and the appropriate level of preoperative evaluation are challenging given the current lack of evidence or precedent. The following guidance is intended to aid hospitals, surgeons, anesthesiologists, and proceduralists in evaluating and scheduling these patients. The updated recommendations detailed in this document are based upon new evidence that has come to light over the past year. The recommendations will be subject to continued evolution as new evidence emerges.



American Society of  
**Anesthesiologists™**



Anesthesia  
Patient Safety  
Foundation

- 
- ▶ The decision for surgery/procedure is centered on two factors
    1. Is the patient **still infectious**?
    2. For patients that are no longer infectious what is the **appropriate length of time** to wait between recovery from COVID and surgery/procedure in terms of risk to the patient

# What determines when a patient confirmed to have COVID-19 is no longer infectious ?

- ▶ Repeat RT-PCR testing may detect SARS-CoV-2 RNA for a prolonged period after symptoms first appear
- ▶ It is rare to recover replication-competent virus after 10 days from onset of symptoms
- ▶ Except in people who have severe COVID-19 or who are moderately or severely immunocompromised
- ▶ CDC recommends discontinuing isolation and other transmission-based precautions per the following

# People who are infected but asymptomatic

- ▶ Day 0 being the date their specimen was collected for the positive test
- ▶ Isolation can end at least 5 days after the first positive test
- ▶ Continue to wear a properly well-fitted mask around others for 5 more days after the 5-day isolation period
- ▶ If symptoms develop after a positive test, their 5-day isolation period should start over

# Children and adults with mild, symptomatic COVID-19

- ▶ Day 0 is the first day of symptoms
- ▶ Isolation can end at least 5 days after symptom onset and after fever ends for 24 hours and symptoms are improving
- ▶ Continue to properly wear a well-fitted mask around others for 5 more days after the 5-day isolation period

# People who have moderate COVID-19 illness

- ▶ Day 0 is the first day of symptoms
- ▶ Isolate for 10 days.

# People who are severely COVID-19 illness

- ▶ Extending the duration of isolation and precautions to at least 10 days and up to 20 days after symptom onset
- ▶ And after fever ends
- ▶ And symptoms are improving

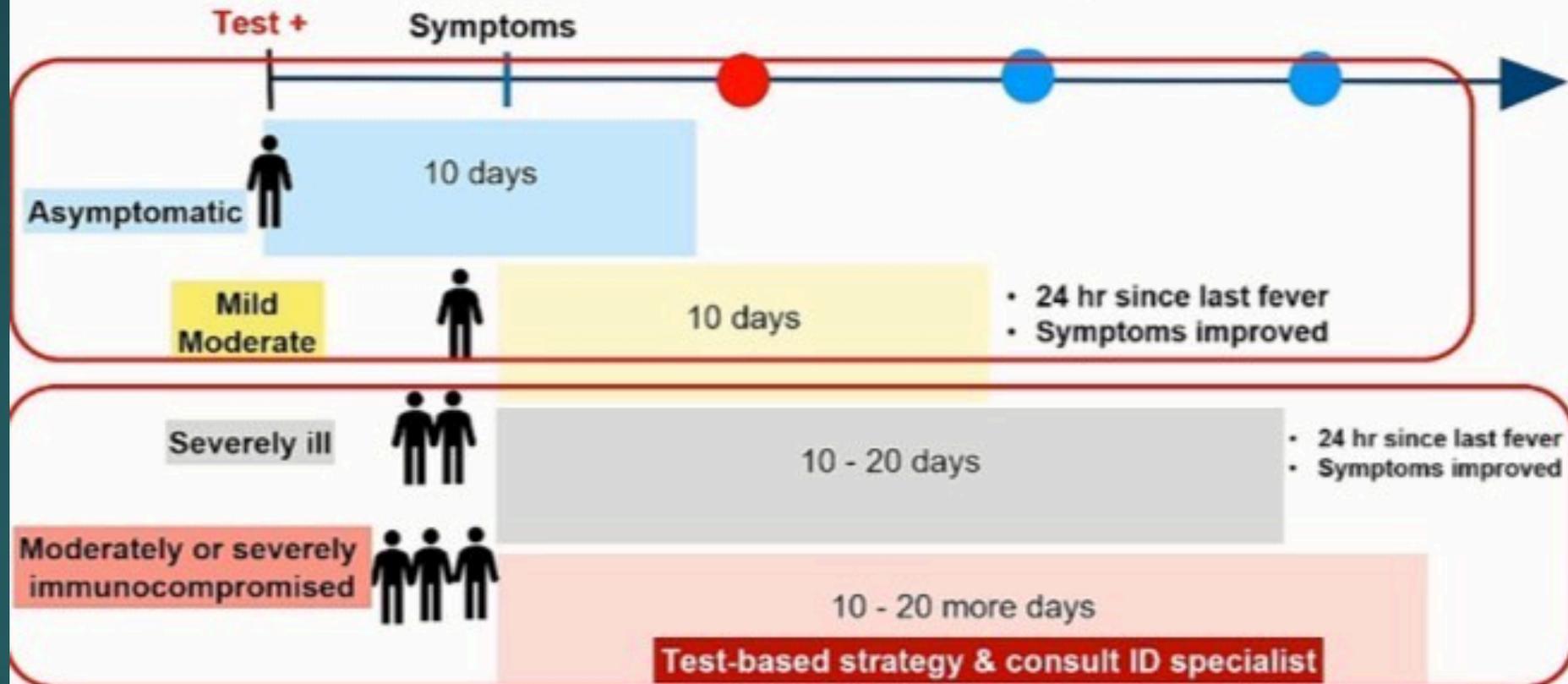
# People who are moderately or severely immunocompromised

- ▶ May have a longer infectious period
- ▶ Day 0 is the first day of symptoms or a positive viral test
- ▶ Extend isolation to 20 or more days
- ▶ Use a test-based strategy and consult with an infectious disease specialist to determine the appropriate duration of isolation and precautions

# CDC recommendations

- ▶ Consultation with infection control experts is strongly advised prior to discontinuing precautions for patients with severe to critical illness or who are severely immunocompromised
- ▶ Maintaining transmission-based precautions and repeat RT-PCR testing may be appropriate if clinical suspicion of ongoing infection exists

# Transmissibility



# Vaccination

- ▶ Complete vaccination for COVID-19 using the Pfizer or Moderna vaccines **two weeks before undergoing a surgical procedure** is associated with lower postoperative morbidity.
- ▶ This protective effect may extend to patients who have never previously tested COVID-19 positive

**TABLE 2.** Primary and Secondary Outcomes in Vaccinated Patients Undergoing Surgery Versus Propensity Score Matched Patients Undergoing Surgery Without Prior Vaccination

	<b>Control<sup>a</sup></b> <b>N = 7438</b> <b>N (%)</b>	<b>Vaccination<sup>a</sup></b> <b>N = 3104</b> <b>N (%)</b>	<b>IRR<sup>b</sup>(95% CI)</b>	<b>P-value<sup>c</sup></b>
Mortality	45 (0.6)	13 (0.4)	0.63 (0.32,1.13)	0.14
COVID-19 positive after surgery	25 (0.3)	1 (0.0)	0.09 (0.01,0.44)	0.02
Composite pulmonary complications <sup>d</sup>	222 (3.0)	53 (1.7)	0.54 (0.39,0.72)	<0.001
Composite thrombotic complications <sup>e</sup>	114 (1.5)	35 (1.1)	0.68 (0.46,0.99)	0.05
Readmissions	277 (3.7)	97 (3.1)	0.8 (0.63,1.00)	0.06
Hospital length of stay [median (IQR)]	2.00 [1.00, 6.00]	2.00 [1.00, 5.00]	0.78 (0.69,0.89)	<0.001

CCI indicates Charlson Comorbidity Index; CI, confidence interval; IQR, interquartile range; IRR, incidence rate ratio.  
aevent numbers and unadjusted rates.

bincidence rate ratio with Control group as Reference (1.00) in a Poisson regression model adjusting for age and CCI.

cp-value for incidence rate ratio adjusting for age and CCI.

d30-day pulmonary complications: pneumonia, mechanical ventilation, acute respiratory distress syndrome, or acute respiratory failure.

e30-day thrombotic complications: deep vein thrombosis, pulmonary embolism, myocardial infarction, ischemic stroke, and arterial thrombosis.

What is the appropriate length of time between recovery from COVID-19 and surgery/procedure with respect to minimizing postoperative complications ?

# Delaying surgery for patients with a previous SARS-CoV-2 infection

- ▶ An early limited study of 122 patients found a significantly higher risk of pulmonary complications within the first four weeks after SARS-CoV-2 diagnosis

Table 1 Outcomes of operated patients with a previous SARS-CoV-2 positive swab				
30-day postoperative outcomes	Previous SARS-CoV-2 positive swab N = 122	Time from previous SARS-CoV-2 positive swab		
		1 to 2 weeks N = 27	2 to 4 weeks N = 60	> 4 weeks N = 35
<b>Pulmonary complications</b>	<b>9.8%</b> (5.2%-16.6%) 12/122	<b>18.5%</b> (6.3%-38.1%) 5/27	<b>11.7%</b> (4.8%-22.6%) 7/60	<b>0.0%</b> (0.0%-10.0%) 0/35
<b>Mortality</b>	<b>3.4%</b> (0.9%-8.4%) 4/119	<b>7.7%</b> (0.9%-25.1%) 2/26	<b>3.4%</b> (0.4%-11.7%) 2/59	<b>0.0%</b> (0.0%-10.3%) 0/34

Previous positive swab is defined as a confirmed SARS-CoV-2 infection by nasopharyngeal swab (qRT-PcR) greater than one week before the day of surgery. Postoperative pulmonary complications were defined as pneumonia, acute respiratory distress syndrome or unexpected ventilation. Outcomes were defined up to 30 days from the day of surgery with Day 0 as the day of surgery. Full definitions are available in the Appendix.

# Delaying surgery for patients with a previous SARS-CoV-2 infection

- ▶ A Brazilian study of 49 patients who underwent surgery with a median delay of 25 days after asymptomatic COVID-19 did not have increased complications when compared to a cohort of patients with a negative SARS-CoV-2 test

**TABLE 2** Clinical and demographic characteristics of the 147 patients submitted to surgical procedures from April 22 to July 2, 2020

Variable		COVID-neg <sup>a</sup> group n = 98 (%)	COVID-rec <sup>b</sup> group n = 49 (%)	p value	Total 147 (%)
Age, mean; median (range) year		49.8; 51 (16–81)	50.1; 52 (13–81)	.86	49.9; 51 (13–81)
Body mass index, mean; median (range) kg/m <sup>2</sup>		26.8; 25.9 (16.9–53.9)	27.6; 27.5 (18.8–43)	.33	27.1; 26.6 (16.9–53.9)
Surgical time length, mean; median (range) (min)		119.0; 100 (10–670)	110.2; 79 (10–362)	.54	116.1; 93 (10–670)
Hospital stay length, mean; median (range) (days)		3.48; 1.0 (0–62)	3.08; 1.0 (0–47)	.28	3.35; 1.0 (0–62)
Gender	Male	40 (40.8)	16 (33.3)	.38	56 (38.4)
	Female	58 (59.2)	32 (66.7)		90 (61.6)
ASA <sup>c</sup>	1 and 2	82 (83.7)	44 (89.8)	.31	126 (85.7)
	3 and 4	16 (16.3)	5 (10.2)		21 (14.3)
ECOG <sup>d</sup>	0 and 1	83 (84.7)	42 (85.7)	.87	125 (85.0)
	2 and 3	15 (15.3)	7 (14.3)		22 (15.0)
Surgical type	Oncological	53 (54.1)	25 (51.0)	.72	78 (53.1)
	Nononcological	45 (45.9)	24 (49.0)		69 (46.9)
Surgical Department	Gastrointestinal	17 (17.3)	10 (20.4)	.73	27 (18.4)
	Gynecology	16 (16.3)	10 (20.4)		26 (17.7)
	Breast	21 (23.5)	5 (14.3)		26 (17.7)
	Skin Cancer	14 (14.3)	5 (10.2)		19 (12.9)
	Urology	12 (12.2)	7 (14.3)		19 (12.9)
	Head and Neck	11 (11.2)	7 (14.3)		18 (12.2)
	Others <sup>e</sup>	8 (8.2)	4 (8.2)		12 (8.2)
Intensive care unit	No	92 (93.9)	41 (85.4)	.12	133 (91.1)
	Yes	6 (6.1)	7 (14.6)		13 (8.9)
Morbidity (Clavien–Dindo <sup>f</sup> )	none	84 (85.7)	41 (83.7)	.74	125 (85.0)
	I	1 (1.0)	2 (4.1)		3 (2.0)
	II	7 (7.1)	2 (4.1)		9 (6.1)
	IIIa	3 (3.1)	3 (6.1)		6 (4.1)
	IIIb	1 (1.0)	1 (2.0)		2 (1.4)
	IVa	1 (1.0)	0 (0)		1 (0.7)
	IVb	1 (1.0)	0 (0)		1 (0.7)

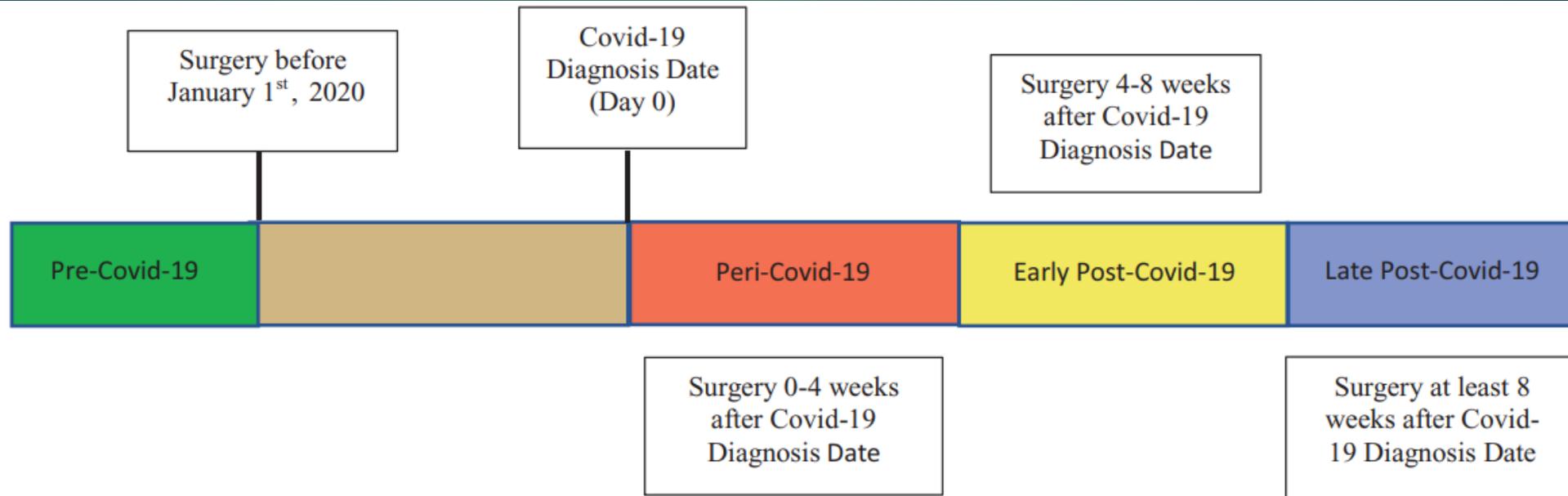
# Timing of surgery following SARS-CoV-2 infection

- ▶ Increased risks of mortality and morbidity—especially with **pulmonary complications** up to 7 weeks post COVID diagnosis
- ▶ Patients with ongoing symptoms at  $\geq 7$  weeks were at increased risk for complications versus patients without symptoms

Interval Between COVID Diagnosis and Surgery	30-day Mortality Rate for Elective Patients (% , CI)**
No COVID Diagnosis	0.62 (0.57-0.67)
0-2 weeks	3.09 (1.64-4.54)
3-4 weeks	2.29 (1.06-3.53)
5-6 weeks	2.39 (0.87-3.91)
$\geq 7$ weeks	0.64 (0.20-1.07)

# The Risk of Postoperative Complications After Major Elective Surgery in Active or Resolved COVID-19 in the United States

- ▶ Patients were categorized into four groups based on the time of surgery relative to the Covid-19 diagnosis date
- ▶ The primary outcomes of interest for the present study were postoperative pneumonia and respiratory failure
- ▶ Secondary outcomes included DVT, PE, arrhythmia, and sepsis



**FIGURE 2.** Surgery timing categories relative to Covid-19 diagnosis date.

**TABLE 1. Postoperative Outcomes**

<b>Outcomes</b>	<b>Pre-Covid-19 Surgery Before January 1, 2020 (n = 2621)</b>	<b>Peri-Covid-19 Surgery 0 to 4 Weeks After Covid-19 (n = 780)</b>	<b>Early Post-Covid-19 Surgery 4 to 8 Weeks After Covid-19 (n = 445)</b>	<b>Late Post-Covid-19 Surgery at Least 8 Weeks After Covid-19 (n = 1633)</b>	<b><i>P</i> Value</b>
Postoperative pneumonia	33 (1.3%)	57 (7.3%)	11 (2.5%)	23 (1.4%)	<0.001
Postoperative respiratory failure	62 (2.4%)	57 (7.3%)	11 (2.5%)	45 (2.8%)	<0.001
Postoperative pulmonary embolism	18 (0.7%)	14 (1.8%)	3 (0.7%)	16 (1.0%)	0.039
Postoperative sepsis	30 (1.1%)	33 (4.2%)	9 (2.0%)	20 (1.2%)	<0.001
Postoperative arrhythmia	50 (1.9%)	13 (1.7%)	13 (2.9%)	37 (2.3%)	0.41
Postoperative renal failure	68 (2.6%)	36 (4.6%)	10 (2.3%)	58 (3.6%)	0.017
Postoperative urinary tract infection	69 (2.6%)	22 (2.8%)	11 (2.5%)	46 (2.8%)	0.097
Postoperative deep vein thrombosis	35 (1.3%)	15 (1.9%)	6 (1.4%)	28 (1.7%)	0.59
Any postoperative complication	270 (10.3%)	131 (16.8%)	52 (11.7%)	183 (11.2%)	<0.001

# Timing of elective surgery and risk assessment after SARS-CoV-2 infection

- ▶ Asymptomatic SARS-CoV-2 infection increased mortality risk around three-fold throughout the 6 weeks after infection
- ▶ The increased risk associated with surgery after SARSCoV-2 infection does not fall until 7 weeks
- ▶ Patients with persistent symptoms and those with moderate-to-severe COVID-19 likely to be at greater risk of morbidity and mortality, even after 7 weeks
  - ▶ Balancing this risk against any risks associated with such delay



**STEP 1** Assess the patient's **BASELINE** risk and explain this to the patient.

➔ Baseline risk is the most important factor determining patient outcome.<sup>1</sup>

<b>Baseline risk</b>	<b>High</b> Surgical mortality risk >1% with validated tool <sup>2</sup>	<b>Intermediate</b> Lower risk of death, but risk of significant complications	<b>Low</b> Low risk of death and complications
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<b>Surgery</b>	<i>Most inpatient gastrointestinal, hepatobiliary, head and neck, cardiothoracic, vascular and complex orthopaedic surgery</i>	<i>Other types of surgery (e.g. breast, primary uncomplicated orthopaedics, most plastic surgery)</i>	<i>Most outpatient eye surgery Minor body surface or extremity surgery</i>
<b>Patient</b>	<i>Frail, deconditioned, unwell or comorbid</i>	<i>Moderately fit and without frailty</i>	<i>Fit and well</i>

**STEP 2** Consider factors that create **ADDITIONAL** risk of proceeding with surgery within 7 weeks and explain this to the patient (risk modifiers).

➡ Risk is cumulative: each risk factor has a bigger impact on a patient with high baseline risk than on a patient with low baseline risk.<sup>3</sup>

- Age > 70 years
- ASA physical status 3-5<sup>4</sup>
- Major surgery
- Ongoing COVID-19 symptoms
- Previously hospitalised for COVID-19

Additional risk	<b>High</b> >1 risk factor	<b>Intermediate</b> 1 risk factor	<b>Low</b> No risk factors
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**STEP 3** Now consider risk of deferring surgery for 7 weeks after SARS-CoV-2 infection.

➔ Clinicians and patients should balance the baseline (Step 1) and additional risk (Step 2) of proceeding with surgery against the risks of waiting.

**STEP 4** Complete agreed outcome.

<b>Outcome</b>	<i>Proceed</i>	<i>Defer</i>	<i>Undecided<sup>5</sup></i>
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# Recommendations

- ▶ **Avoid** elective surgery **within 7 weeks** of SARS-CoV-2 infection
  - ▶ The benefits of doing so exceed the risk of waiting
- ▶ Surgical patients should have received pre-operative COVID-19 vaccination
  - ▶ 3 doses
  - ▶ Last dose at least 2 weeks before surgery
- ▶ Respiratory protective equipment
- ▶ Elective surgery should **not take place within 10 days of diagnosis** of SARS-CoV-2 infection

# Recommendations

- ▶ If elective surgery is considered within 7 weeks of diagnosis of SARS-CoV-2 infection
  - ▶ All patients should have their risk of mortality calculated using a validated risk score
  - ▶ Risk modifiers based on patient factors, SARS-CoV-2 infection, surgical factors
- ▶ Patients with persistent symptoms and those with moderate-to-severe COVID-19 remain likely to be at greater risk of morbidity and mortality, even after 7 weeks
- ▶ Avoidance of general anesthesia in favour of local or regional anesthetic techniques should be considered

Is repeat SARS-CoV-2 testing needed?

- ▶ CDC **does not recommend** re-testing for COVID-19 within 90 days of symptom onset
  - ▶ If a patient presents within 90 days and has **recurrence of symptoms**, re-testing and **consultation with an infectious disease expert** should be considered
- ▶ Once the 90-day recovery period has ended
  - ▶ Patient should undergo **one pre-operative nasopharyngeal PCR test** ideally **≤ three days** prior to the procedure

# Preoperative Considerations

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## Journal of Clinical Anesthesia

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Correspondence

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



**Table 1**

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

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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

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# Neurologic considerations

- ▶ Range from dizziness and headache to encephalitis, seizures and stroke and demyelinating polyneuropathy
- ▶ If a patient presents with evidence of peripheral neuropathy
  - ▶ Judicious use of opiates and neuromuscular blockers (NMBs)
  - ▶ Quantitative monitoring of NMB reversal
  - ▶ Avoidance of regional anesthesia may also be advisable
- ▶ Patients might also be encouraged to consult a Neurologist postoperatively

# Cardiovascular considerations

- ▶ SARS-CoV-2 infection is associated with significant adverse cardiovascular effects 20–30%
  - ▶ Acute myocardial injury
  - ▶ Dysrhythmias
  - ▶ Ischemic or non-ischemic cardiomyopathy
- ▶ Surveillance EKG and TTE have been recommended for COVID-19 patients 2–6 months after acute infection
- ▶ A low threshold for pre-operative transthoracic echocardiography (TTE) or further evaluation may be appropriate

# Pulmonary considerations

- ▶ COVID-19 may cause long-lasting pulmonary injury
- ▶ Small-airway dysfunction and new-onset restrictive lung disease have also been described in recovered COVID-19 patients
- ▶ Surveillance PFTs and lung imaging may be indicated
- ▶ If general anesthesia is planned, it may be prudent to emphasize the possibility of postoperative mechanical ventilation

# Renal considerations

- ▶ Moderate or severe SARS-CoV-2 infection is frequently associated with acute kidney injury (AKI)
- ▶ 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

# Hematologic considerations

- ▶ Critically ill COVID-19 patients are at particular risk of thromboses
- ▶ “Enhanced Recovery After Surgery” (ERAS) protocols
  - ▶ Early ambulation
  - ▶ Reduce venous thromboembolism risk

**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

# Preoperative Evaluation

# Pre-anesthetic Evaluation

- ▶ Aimed at assessment of the functional status of the patient
- ▶ Evaluation should include proper history and physical examination
- ▶ ASA physical status of the patient
- ▶ Type of surgical procedure
- ▶ Clinical manifestations of the disease

**Cardiovascular system:**

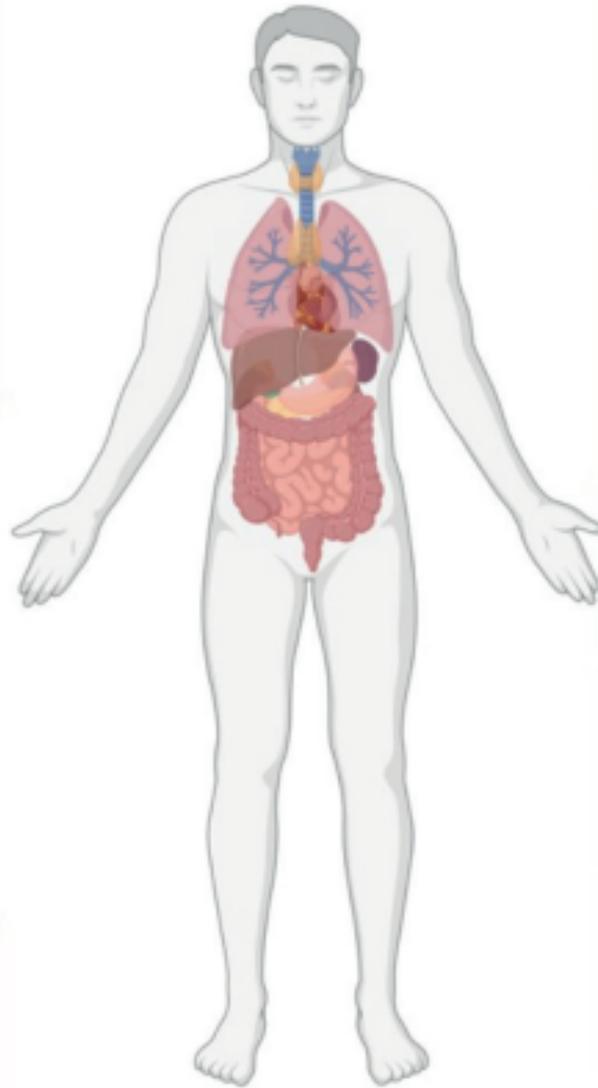
- fatigue;
- chest pain;
- arrhythmias;
- worsening of heart failure;
- arterial thrombosis in various territories;
- venous thrombosis;
- pulmonary embolism.

**The central nervous system:**

- persistent loss of smell and taste;
- sleep disturbances;
- concentration problems;
- memory loss;
- headache;
- poly-radiculopathy;
- encephalitis;
- ischemic stroke;
- cerebral sinus thrombosis;

**Metabolic:**

- sudden onset of type II diabetes mellitus;
- worsening hypothyroidism;
- persistent inflammatory syndrome;

**Psychiatric symptoms:**

- depression;
- anxiety disorders;
- frequent mood swings;

**Respiratory system:**

- shortness of breath;
- cough;
- dyspnea;
- prolonged need for supplemental oxygen;
- pulmonary fibrosis;

**Renal system:**

- acute kidney injury;
- deterioration of previous renal failure;

**Dermatologic system:**

- hair loss;
- rashes;
- skin lesions;

**Miscellaneous symptoms:**

- joint pain;
- muscle pain;
- intermittent fever;

**Figure 1.** Post COVID-19 symptoms.

# Preoperative Investigations

**Table V.** Preoperative assessment of a recovered COVID-19 patient scheduled for elective surgery.

Step/test	Minor procedures and/or without general anesthesia		Major procedures		
	Asymptomatic form of COVID-19 in medical history	Moderate or severe form of COVID-19 in medical history	Asymptomatic	Moderate form of COVID-19 in medical history	Severe form of COVID-19 in medical history
Chest X-Ray	No—if pulmonary exam and O <sub>2</sub> sat normal	No—if pulmonary exam and O <sub>2</sub> sat normal	Yes	Yes	No
Chest Computed Tomography	No—if pulmonary exam and O <sub>2</sub> sat normal	No—if pulmonary exam and O <sub>2</sub> sat normal	No—if pulmonary exam and O <sub>2</sub> sat normal	+/- (can replace Chest X-ray)	Yes
EKG	Yes	Yes	Yes	Yes	Yes
Echo	No—if cardiac exam and vitals normal	No—if cardiac exam, NT-pro-BNP, and vitals normal	No—if cardiac exam, NT-pro-BNP, and vitals normal	Determined by H&P	Yes
CMP	Yes	Yes	Yes	Yes	Yes
CBC, with diff	Yes	Yes	Yes	Yes	Yes
PTT	No	Consider based on severity of illness	Yes	Yes	Yes
D-dimer	No	Yes	Yes	Yes	Yes
Fibrinogen	No	Consider based on severity of illness	Yes	Yes	Yes
NT-pro-BNP	No	Yes	Yes	Yes	Yes
LDH, ferritin, prealbumin	No	Consider based on severity of illness	No	Consider based on severity of illness	Yes
Spirometry (FVC, FEV1, TLC)	No	Yes	No	Yes	Yes
Lung diffusion capacity (DLCO, DLCO/VA)	No	No	No	No	Yes

**Table 1: Tests for pre-operative evaluation in post-COVID-19 patients**

Tests	<sup>I</sup> Minor Procedures		<sup>II</sup> Intermediate Procedures		<sup>III</sup> Major Procedures	
	*Asymptomatic (ASAPS-I)	**Symptomatic (ASAPS II, III, IV)	*Asymptomatic (ASAPS-I)	**Symptomatic (ASAPS II, III, IV)	*Asymptomatic (ASAPS-I)	**Symptomatic (ASAPS II, III, IV)
CBC (Hb, WBC differential count, Platelet count, others)	Yes	Yes	Yes	Yes	Yes	Yes
Coagulation profile (BT, CT, PT, INR, APTT)	Yes	Yes	Yes	Yes	Yes	Yes
CXR	No (If SpO2 normal/Clinically normal)	No (If SpO2 normal/Clinically normal)	No (If SpO2 normal/Clinically normal)	Yes	Yes	Yes
ECG	Yes	Yes	Yes	Yes	Yes	Yes
Serum Electrolytes	Yes	Yes	Yes	Yes	Yes	Yes
RBS	No	Yes	Yes	Yes	Yes	Yes
LFTs	No	No	No	No	No	Yes
RFTs (BUN, Serum Creatinine)	No	Yes	Yes	Yes	Yes	Yes
D-dimer	No	Yes	No	Yes	Yes	Yes
Fibrinogen	No	consider based on the severity of illness	No	Yes	Yes	Yes
NT Pro-BNP	No	Yes	No	Yes	Yes	Yes
LDH/Ferritin/prealbumin	No	consider based on the severity of illness	No	Yes	No	consider based on the severity of illness
2 D Echo	<ul style="list-style-type: none"> <li>-Patients who had moderate/severe hypoxia or significant cardiac symptoms during COVID-19</li> <li>-Patients posted for major abdominal/thoracic/cardiac/vascular surgeries</li> <li>-Geriatric patient</li> <li>-Obstetric patient</li> <li>-Those with signs of heart failure/abnormal ECG report/structural heart disease</li> </ul>					
HRCT chest, PFTs, ABGs	<ul style="list-style-type: none"> <li>-Patients who had moderate/severe hypoxia or significant cardiac symptoms during COVID-19</li> <li>-Patients posted for major abdominal/thoracic/cardiac/vascular surgeries</li> <li>-Geriatric patients</li> </ul>					
Troponin 1	<ul style="list-style-type: none"> <li>-Patients who had significant cardiac symptoms during COVID-19</li> <li>-Patients posted for major abdominal/thoracic/cardiac/vascular surgeries</li> </ul>					

# Pre-operative preparation

- ▶ Patients awaiting surgery are **recommended to accept a vaccine** unless contraindicated
- ▶ Prehabilitation
- ▶ Cessation of smoking
- ▶ Chest physiotherapy
- ▶ Correction of hydration status
- ▶ Improvement in nutrition
- ▶ Control of hyperglycemia

# Intraoperative management

- ▶ Pre-operative anxiolysis
- ▶ RA including neuraxial blocks and ultrasonography-guided nerve blocks should be preferred over GA
- ▶ Optimal oxygenation by providing adequate inspired oxygen concentration should be ensured when administering general anesthesia (GA)
- ▶ Heat and moisture exchange filters should be used to maintain mucociliary function

# Intraoperative management

- ▶ Propofol or etomidate can be used as induction agents
- ▶ Vecuronium, cis-atracurium and atracurium can be used as agents for neuromuscular blockade
- ▶ Suxamethonium or rocuronium can be used for rapid sequence tracheal intubation
- ▶ The anesthesia is maintained preferably with an air-oxygen mixture and inhalational agents
- ▶ Sevoflurane may be preferred for maintenance of anesthesia considering its effective bronchodilation effect and rapid removal

# Intraoperative management

- ▶ Adequate reversal of the neuromuscular block is important
  - ▶ Neuromuscular monitors
- ▶ **Awake extubation** should be performed provided the patient does not have any significant cardiac ailment
- ▶ Post-extubation continuous positive airway pressure or high-flow nasal oxygen can be administered where necessary
- ▶ Patients should be monitored closely for respiratory failure or deterioration

# Intraoperative management

- ▶ Intra-operative analgesics : fentanyl
- ▶ Multimodal analgesia should be employed in all cases
- ▶ Epidural analgesia should be planned in laparotomies and employed where feasible to optimise post-operative analgesia and ease breathing

# Intraoperative management

- ▶ Emergency caesarean section in COVID-19 recovered women
  - ▶ RA is the preferred technique
  - ▶ Early ambulation

# Intraoperative management

- ▶ In patients with renal dysfunction
  - ▶ Avoid drug induced nephrotoxicity
  - ▶ Hyperkalemia
  - ▶ Hemodynamic monitoring

# Post-operative care including analgesia

- ▶ Shifting of the patient to the ICU/ward
  - ▶ oxygen supplementation
  - ▶ ventilatory support
- ▶ **Multi-modal analgesia** can be provided using epidural analgesia, nerve blocks, neuromodulators, opioids, tramadol, paracetamol and NSAIDs
- ▶ NSAIDs should be avoided in patients with renal dysfunction

# Take Home Messages

- ▶ Vaccination is important
- ▶ RT-PCR is **not necessary** within 90 days of symptom onset
- ▶ Optimal timing before elective surgery ( **7 weeks or more after** )
- ▶ Preoperative evaluation
  - ▶ Respiratory system
  - ▶ Cardiovascular system
  - ▶ Neurological system

# Take Home Messages

- ▶ Preferred RA than GA
- ▶ Multimodal analgesia
- ▶ Postoperative complications
  - ▶ Pneumonia
  - ▶ Respiratory failure

Thankyou