GLOBAL SCIENCE LIBRARY

RESEARCH

Anesthesia and Perioperative Medicine

# Perioperative Considerations for Covid-19 Patients: Implementation Science-based Approach for Practicing Perioperative Surgical Home (PSH)

**Neil Shah[1], Chunyuan Qiu[1], Elena Chung[1], Mildred Lopez[1], Mark Feng[2] and Vimal N Desai[1]***

[1]*Department of Anesthesiology, Kaiser Permanente Baldwin Park Medical Center, Baldwin Park, USA*
[2]*Department of Urology, Kaiser Permanente Baldwin Park Medical Center, USA*

## Abstract

*The Covid-19 pandemic presents unprecedented challenges for anesthesia professionals and their surgical patients. Beyond managing the infection risk, positive Covid-19 surgical patients add additional challenges to their perioperative care, where perioperative risk is superimposed onto an already baseline anesthesia risk in real-time in an unknown and unpredictable fashion. Recent evidence suggests that surgical procedures for both current and recovered Covid-19 patients are associated with elevated morbidity and mortality. These risks must be well managed. However, the anesthetic risk aside from transmission is yet to be fully understood; consequently, effective and speedy dissemination of practice changes is vital to effective health care delivery. However, the traditional "knowledge to action gap" of 17 years or more in healthcare is a hinderance. We herein designed and implemented a new but simple perioperative criterion for previous Covid-19 patients based on the principle of the perioperative surgical home (PSH) within the Consolidated Framework for Implementation Research (CFIR). Given these tools, implementation and/or implementation components of the pathways based on recommendations which are fast evolving can readily be done, nearly live.*

**Keywords:** *Covid-19, surgery, evaluation, implementation science, perioperative surgical home, anesthesiology, long covid*

## Core tip

Covid-19 carries short and long-term sequalae on patients' health and wellness. As such, a well-established and executed plan for Covid surgical patients is necessary. While it depends on the surgeon to make the right surgical decision, it is in the best interest of the anesthesiologists to complete a covid-19 specific review for optimization as these patients are at higher risk of long-term pulmonary emboli, respiratory compromise, hepatic derangement, cardiac dysfunction, and renal abnormalities. In the middle of a pandemic, a system and method for fast evidence acquisition and rapid implementation are not only necessary but crucial.

## Introduction

The pandemic affects all aspects of healthcare industry from speed of cultural change, cost, and patient well-being. Current wide spread of the Delta variant ushers in a new dimension to our already strained healthcare system and challenges the validity of our knowledge obtained from its wild type. Over 220 million have been infected with over 4.6 million deaths (at the time of submission) [1,2]. In the pediatric population 658,753 deaths have been reported in the US as per the CDC [3]. Evidence suggests that recovered patients need continued monitoring and vigilance due to the short and long term sequala of the disease despite the associated cost. At the time of this manuscript, there are over 198 million recovered Covid-19 patients worldwide, their need for surgical and anesthesia care is growing but optimal and precision perioperative management is yet to be determined.

Like all RNA virus, SARS-Cov-2 is prone to mutation while adapting to human hosts, which can result in variants that may possess different characteristics than its wild-type. While vaccination, contact tracing, social distancing and personal protective equipment (PPE) in preventing transmission are still important, unfortunately PCR testing is still controversial as it is inconsistently related to the infectiousness or severity of Covid disease [4]. Viable virus can be detected 2-3 days before and 5 days after symptoms onset, but Covid RNA shedding as detected by RT-PCR can be persistent, ranging from an average of 17 days in the upper airway, 14.6 days in the lower respiratory tract, 17.2 days in stool and 16.6 days in serum [5,6]. The infectiousness of Covid-19 virus is often short lived inside the human body and positive RT-PCR test result without clinical correlation may have limited value [7,8].

The above uncertainties, when intertwined with SARS-CoV-2 wild-type or variants infection, vaccination and unknown nature of immunization weaning, presents a unique challenge to perioperative professionals because of this incomplete knowledge. This reality is in a direct collision course with healthcare tradition, where evidence must be clear and "knowledge to action gap" is unreasonably long [9,10]. Clinically, there is a vacant need for fast dissemination of emerging evidence and then fast introduction to clinical practice in a dynamic and continuous manner. In our efforts, we innovated a new program based on two principles: Perioperative Surgical Home (PSH) and Consolidated Framework for Implementation Research (CFIR)—a designed framework that practically helps in real-world translative implementation. The importance of speedy implementation from a reliable framework is critical as we have learnt from this pandemic since it leads to timely modification and updates and resultant implementation.

## Practice environment

Kaiser Permanente (KP) hosts one of the largest integrated delivery systems (IDS). It is composed of 3 integrated and interdependent groups: Kaiser Foundation Health Plan (insurance), Kaiser Foundation Hospitals (hospitals), and Permanente Medical

| Case Classification | Peak COVID Severity | | Minimum Recovery Time[1] |
|---|---|---|---|
| **Emergent/Urgent** | Balance disease risk vs infectious risk (18 days)[2] | | Documented surgical emergency/urgency |
| **Elective**[3] | **Class - A** | ASYMPTOMATIC | ≥1 month |
| | **Class - B** | SYMPTOMATIC, DIABETIC, IMMUNOCOMPROMISED | ≥2 months |
| | **Class - C** | HOSPITALIZED | ≥3 months |

1. **Recommendations only. Clinical judgement, risk assessment, and individualized timelines may be necessary.**
2. **Case by case consideration of surgical disease, COVID symptoms, physiologic effects of COVID, and infectious risk.**
3. **Elective classification assumes full recovery or establishment of a new, stable clinical baseline.**

| Universal Evaluation | COVID Considerations[1] | Additional Tests & Evalaution[2] | Anesthetic Considerations |
|---|---|---|---|
| **In-depth H&P** | Generalized weakness | D-dimer, fibrinogen, CRP, ferritin | Difficult intubation/extubation |
| **Risk class (as above)** | Swallowing difficulty/aspiration | Cultures | Aspiration/ laryngospasm risk |
| **Functional capacity (METs)** | Reactive airways | LFTs, BNP | Lower TV/PEEP/Ppeak |
| **Baseline mental status** | Pneumothorax | EKG, CXR, CT Chest | Higher FiO2 |
| | Pneumomediastinum | Echocardiogram | Higher narcotic requirements |
| CBC with diff, CMP, INR | Secondary infections, sepsis | Stress echocardiogram | Reduced muscle relaxants |
| | Cardiovascular complications | Deep venous ultrasound (DVT U/s) | Avoid TXA |
| **Procedure type** | DVT, Pulmonary embolism | CT/MRI Brain | |
| Alternative treatment | Mental status changes | Specialist Consults | Maintain baseline MAP |
| | Cerebrovascular complications/Stroke | | +/- arterial line, central line |
| **Anesthetic options** | Renal failure/ATN | **Repeat COVID testing** | +/- vasopressors |
| | Diabetes, Obesity | **(only 3 months after original test)** | Targeted fluid therapy |
| | Other: Age, Gender, Home O2 | | Cheetah, ExSpiron, BIS/Sedline |

1. COVID considerations for all phases of perioperative care (preop, intraop, postop)
2. Additional assessments to be individualized to H&P, functional capacity, type of surgery and anesthetic

*Figure 1: Recommendation for the Perioperative Management for Previously COVID+ Patients (updated)*

Groups (physicians). This financial and operational exclusive interdependency allows for a much smaller knowledge-to-action gap as we have seen in our management of the pandemic and as outlined in this work. As of September 17, 2021, we managed over 530,236 Covid-19 positive patients both on an inpatient or outpatient basis. Of note, the department is an anesthesiologist only practice with physician assistance for clinical support in the preoperative phase.

## PSH protocol design

Based on the evidence and recommendations from national entities, we developed system-based guidelines for perioperative screening and care (Figure 1). Our Risk-Recovery Assessment tool (Figure 1) creates a guideline that can assist in quick and wide adoption, which is a simple, user-friendly approach to stratifying these patients. For scenarios that fall outside the range as outlined by the risk-recovery assessment tool, we rely on the expertise of our design team and care experts, which include schedulers, surgeons, anesthesiologists, perioperative staff, and administrators.

## Preoperative phase

The focus during this phase of care is on balancing transmissibility risk, emergence/urgency of the surgery, sequalae risk and associated perioperative risk. A 2-week delay of urgent or elective surgery following any Covid vaccination (single dose, 1st dose or 2nd dose) was implemented. The effects of immunomodulation by NSAIDS, steroids or surgical response are undefined; however, the delay could be beneficial especially in cases that are not emergent.

## Intraoperative phase

Utilizing the tool as a checklist, providers can maintain vigilance as to the relevant aspects of patient care that may be affected by Covid-19. This includes its pathophysiological effects and subsequent sequelae such as pulmonary fibrosis or pneumothorax. This guide can optimize disposition, care pathways, and clinical decision making in order to customize for optimal care delivery.

## Postoperative phase

An immediate concern in surgical recovery for our patients is covid related effects on muscle relaxation, respiratory muscle weakness, V-Q mismatch, pulmonary fibrosis, tracheomalacia in patients previously intubated, as well as apnea—both central and peripheral. Vigilance in the presence of oxygenation or ventilation issues is critical, as covid related complications should be higher on the differential. However, improved monitoring technology is beneficial. We implemented the use of non-invasive respiratory monitoring for this patient population. Often pulse oximeter is a delayed indicator of ventilation compromise especially on patients using oxygen. Implementation of noninvasive respiratory monitoring via Exspiron 1xi (Respiratory Motion Inc, Boston, MA), which provides tidal volumes (Tv), minute ventilation (MV), accurate respiratory rate (RR), and a percent of MV calculated with measured MV over patient's ideal minute ventilation based on height, weight and gender (Predictive Minute ventilation – MVpred), was able to give us an early warning sign. (Figure 2) [11-13].

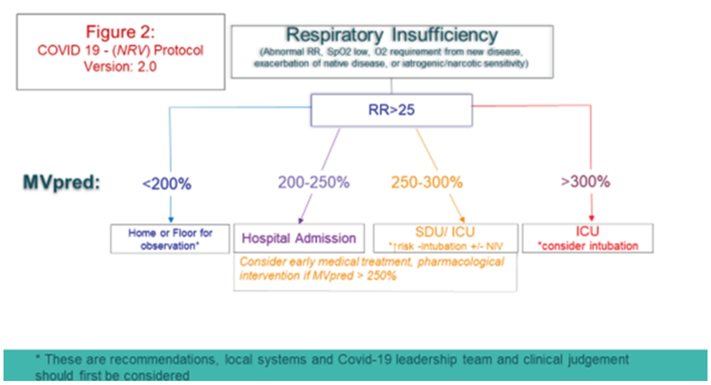


*Figure 2: Respiratory Insufficiency Monitoring with Noninvasive Respiratory Volume (NRV) Monitor Protocol 2.0*

## PSH protocol implementation

### Implementation framework

A modified CFIR pathway through a simultaneous bottom-up and top-down approach was previously described by our team [14-16]. The bottom-up aspect was carried out by the experienced anesthesiologists who actively managed patients in the intensive care unit and perioperative Covid-19 patients, who served as the liaison for bridging the care gaps and set up goals for improvement. This requires involvement and engagement of leaders, stakeholders, policy makers and front-line staff. This OR/perioperative committee in which all pertinent parties are involved make for quick decision making and aid in widespread implementation. .

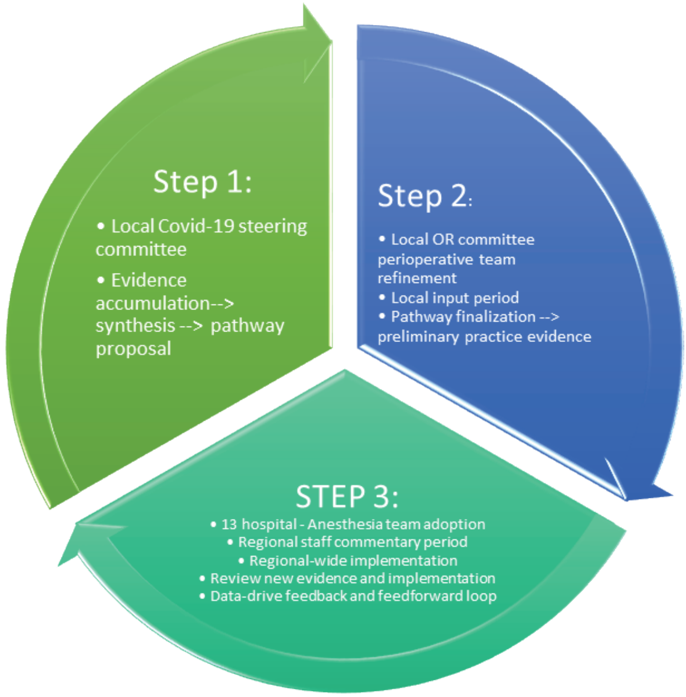


*Figure 3: Covid 19 PSH pathway for Implementation Steps 1 to 3 utilizing the top-down and bottom-up approach (Verison 2.0)*

**Dynamic modelling**

With this aspect of the protocol, we can manage various dynamic interdependencies live [17]. For example, one can determine the interaction benefits and concerns of the pandemic with PPE strategies, vaccine rollout, and perioperative care of the surgical patients. This is vital during viral strain dominance shifts such as that of the delta-variant. Also, the customization and integration of the electronic medical record system played a critical role in communication and in-patient evaluation.

**Implementation process**

The realization that the gap between Covid knowledge and action must be eliminated. Steps of the implementation process are outlined below (Figure 3):

1. Forming a steering committee

Gather evidence

Identify practice gaps

Design pathways.

Our initial guideline and pathway were started in October 2020. At that time, there was little evidence to guide our decision making along with daily changes to our understanding of the virus and the global pandemic. Since then, a tremendous amount of evidence and understanding has been accumulated which has led to a refinement of our guidelines and pathways through feedback and feedforward mechanisms.

2. Formulate the guidelines with frequent and continued improvements biweekly. The burden of implementation had a steep learning curve. However, all stakeholders are now primed to frequent evidence-based updates and discretionary implementation.
3. Spread – based on local success, the guidelines were promptly spread to 13 associated facilities through our regional perioperative leadership team. This included pathways, protocols, cultural changes and affirmation by surgeons, anesthesiologists, certified registered nurse anesthetists (CRNAs), schedulers, and leaders.
4. Review – the data and impact should be continuously evaluated for consistency and implementation

## Discussion

TThe number of impacted elective surgeries continues to grow as a result of the pandemic [18,19]. Under current conditions, how to conduct "evidence-based practice" with limited or evolving evidence in light of the "knowledge to action gap" is an ongoing struggle leading to perioperative system stress. This innovative pathway with the science of implementation is crucial for rapid meaningful healthcare reform in an era of rapid data and communication.

Based on the Perioperative Surgical Home (PSH) principles, which however varies from the previously reported PSH program [14,15], addresses the need of a consistent implementation platform that can simultaneously accommodate frequent updates or component changes. This old but seldomly utilized implementation science can effectively facilitate both feedback and feedforward mechanism for a robust dynamic PSH program. The team members - which includes the perioperative anesthesia and surgical staff, the surgical personal as well the recovery physicians, assistants, nurses and the associated leadership maintained constant contact and frequent updates through pre-defined electronic methods. With the expanding Covid-19 knowledge, all members were responsible for pertinent dissemination of their component of the pathway and pathway design. Setting up an infrastructure of communication and implementing a cultural change through leadership consistency is vital for success. By combining the design team and the implementation team as one, this innovation allowed us to formulate a practical and actionable plan quickly and effectively. This bottom-up and top-down approach enabled us to meet the unprecedented and monumental challenges in a more precise, productive, and efficient fashion.

**Patient components**

1. Multiorgan and system disease - Unrecognized short and long term compromise of specific systems based on covid-19 disease symptoms at the time of infection, such as: neurological, cardiac, pulmonary, hepatic, renal and muscular
2. Exposure- Understanding the timeline and extent of sedatives, therapies, physical compromise (ie. prone ventilation) and opiate exposure during hospital and/or ICU stay which may lead to organ compromise, dependency or resistance.
3. Autonomic system - changes to the feedback systems that regulate stress and immune response due to surgery and anesthesia

Mild or even non-symptomatic patient who were exposed to or infected with Covid-19 may carry a similar risk [20]. There are more than 50 identified long-term effects of Covid-19. Currently, about 76% of discharged patients continue to experience symptoms such as: weakness, myalgia, shortness of breath, anxiety, depression, fatigue syndromes, and sleep disorders. In the "long Covid" or Post-acute sequelae of Sars-CoV-2 infection (PASC), studies demonstrated 52% abnormalities in lung CT and functional test (LEFT) including ground glass opacity, irregular lines, consolidations and fibrosis as well as other systemic abnormalities [21,22]. Our design for the implementation framework is based on this rapidly evolving understanding of Covid-19 consequences.

Although our efforts were to optimize implementation, limits to our study stand. One such limit is the lack of clinical outcomes based on this methodology. However, the design of our study, could not maintain fixed variables as it was based on dynamic change. The pathways were based on research and the implementation framework was directed to bridge the time gap between knowledge and daily practice. Utilizing this bottom-up and top-down approach with a strong communication culture, infrastructure and leadership, we are able to have wider implications for utilizing a dynamic model instead of traditional control groups, to transform medicine and answer the translational medicine problem of obsolete research and its associated implementation gaps.

**Author contributions**: Desai V, Shah N, Chung E, Chunyuan Qiu conceived the idea for the manuscript; All authors reviewed the literature and draft and provided critical review of the manuscript.

**Conflict of interest statement**: Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

**Funding Statement** There are no disclosures for any external sources of funding for this manuscript.

## References

1. Prescott HC. Outcomes for Patients Following Hospitalization for COVID-19. *JAMA*. 2021; 325: 1511-1512.
2. World Health Organization. WHO Coronavirus (COVID-19) Dashboard. 26 March 2021. Available from: https://covid19.who.int/ Cited 26 March 2021
3. Centers for Disease Control and Prevention. Provisional COVID-19 Deaths: Focus on Ages 0-18 Years. Available from: [https://data.cdc.gov/NCHS/Provisional-COVID-19-Deaths-Focus-on-Ages-0-18-Yea/nr4s-juj3] Cited 16 September 2021.
4. Sun K, Wang W, Gao L, Wang Y, Luo K, et al. Transmission heterogeneities, kinetics, and controllability of SARS-CoV-2. *Science*. 2021; 371: eabe2424.
5. Perera RAPM, Tso E, Tsang OTY, Tsang DNC, Fung K, et al. SARS-CoV-2 Virus Culture and Subgenomic RNA for Respiratory Specimens from Patients with Mild Coronavirus Disease. *Emerg Infect Dis*. 2020; 26: 2701-2704.
6. Cevik M, Tate M, Lloyd O, Maraolo AE, Schafers J, et al. SARS-CoV-2, SARS-CoV, and MERS-CoV viral load dynamics, duration of viral shedding, and infectiousness: a systematic review and meta-analysis. *Lancet Microbe*. 2021; 2: e13-e22.
7. Avanzato VA, Matson MJ, Seifert SN, Pryce R, Williamson BN, et al. Case Study: Prolonged Infectious SARS-CoV-2 Shedding from an Asymptomatic Immunocompromised Individual with Cancer. *Cell*. 2020; 183: 1901-1912.e9.
8. Choi B, Choudhary MC, Regan J, Sparks JA, Padera RF, et al. Persistence and Evolution of SARS-CoV-2 in an Immunocompromised Host. *N Engl J Med*. 2020; 383: 2291-2293.
9. Westfall JM, Mold J, Fagnan L. Practice-based research--"Blue Highways" on the NIH roadmap. *JAMA*. 2007; 297: 403-406.
10. Morris ZS, Wooding S, Grant J. The answer is 17 years, what is the question: understanding time lags in translational research. *J R Soc Med*. 2011; 104: 510-520.
11. Qiu C, Cheng E, Winnick SR, Nguyen VT, Hou FC, et al. Respiratory Volume Monitoring in the Perioperative Setting Across Multiple Centers. *Respir Care*. 2020; 65: 482-491.
12. Desai VN, Shah DH, Cohen JM, Winnick SR, Gonzalo C, et al. Triaging Covid-19 Patients in The Emergency Room Using A Respiratory Volume Monitor. Proceedings of the American Society of Anesthesiology Conference; 2020; Washington DC.
13. Desai VN, Shah DH, Mobassery H, Winnick SR, Thomas S, et al. Early Prediction of Covid-19 Patient Deterioration Utilizing Non-Invasive Respiratory Volume Monitoring. Proceedings of the American Society of Anesthesiology Conference; 2020; Washington DC.
14. Saluja S, Silverstein A, Mukhopadhyay S, Lin Y, Raykar N, et al. Using the Consolidated Framework for Implementation Research to implement and evaluate national surgical planning. *BMJ Glob Health*. 2017; 2: e000269.
15. Qiu C, Cannesson M, Morkos A, Nguyen VT, LaPlace D, et al. Practice and Outcomes of the Perioperative Surgical Home in a California Integrated Delivery System. *Anesth Analg*. 2016; 123: 597-606.
16. Qiu C, Rinehart J, Nguyen VT, Cannesson M, Morkos A, et al. An Ambulatory Surgery Perioperative Surgical Home in Kaiser Permanente Settings: Practice and Outcomes. *Anesth Analg*. 2017; 124: 768-774.
17. Peters DH. The application of systems thinking in health: why use systems thinking? *Health Res Policy Syst.* 2014; 12: 51.
18. COVIDSurg Collaborative. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. *Br J Surg*. 2020; 107: 1440-1449.
19. Ljungqvist O, Nelson G, Demartines N. The Post COVID-19 Surgical Backlog: Now is the Time to Implement Enhanced Recovery After Surgery (ERAS). *World J Surg*. 2020; 44: 3197-3198.
20. Lopez-Leon S, Wegman-Ostrosky T, Perelman C, Sepulveda R, Rebolledo PA, et al. More than 50 Long-term effects of COVID-19: a systematic review and meta-analysis. *medRxiv*. 2021; 2021.01.27.21250617.
21. Truffaut L, Demey L, Bruyneel AV, Roman A, Alard S, et al. Post-discharge critical COVID-19 lung function related to severity of radiologic lung involvement at admission. *Respir Res*. 2021; 22: 29.
22. Lechowicz K, Drożdżal S, Machaj F, Rosik J, Szostak B, et al. COVID-19: The Potential Treatment of Pulmonary Fibrosis Associated with SARS-CoV-2 Infection. *J Clin Med*. 2020; 9: 1917.

*Correspondence: Dr. Vimal N. Desai, Department of Anesthesiology, Kaiser Permanente Baldwin Park Medical Center, Baldwin Park, California 91706, USA, E-mail: Chunyuan.x.qiu@kp.org

**Rec**: 13 Aug 2021; **Acc**: 21 Sep 2021; **Pub**: 23 Sep 2021

Anesth Periop Med. 2021;1(1):105
DOI: 10.36879/APM.2021.000105