

## Review Article

# COVID-19: considerations for optimum surgical team protection before, during and after operation

Gaurav Punia<sup>1\*</sup>, Sunaina Kharb<sup>2</sup>, Anil Gulia<sup>1</sup>, Sanjeev Bansal<sup>1</sup>,  
Shashipal Chandan<sup>1</sup>, Mahesh Kumar<sup>1</sup>

<sup>1</sup>Department of Orthopaedics, <sup>2</sup>Department of Respiratory Medicine, BPS GMC (W) Khanpur Kalan, Sonapat, Haryana, India

**Received:** 22 April 2020

**Revised:** 07 June 2020

**Accepted:** 09 June 2020

**\*Correspondence:**

Dr. Gaurav Punia,

E-mail: [gauravpunia264@gmail.com](mailto:gauravpunia264@gmail.com)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

### ABSTRACT

SARS CoV-2, the virus responsible for coronavirus disease 2019 (COVID-19), has caused a global pandemic. Surgeons' obligation, as always, will be to provide timely, high-quality surgical care that achieves the best outcomes for patients. It is imperative to ensure the safety of health-care workers not only to safeguard continuous patient care but also to ensure they do not transmit the virus further. Viral particles have been found in nasal swabs, pharyngeal swabs, sputum, bronchial swabs, gastrointestinal tissue, blood, and stool. Surfaces in isolation rooms and even clinician shoe covers have tested positive as well. Some key considerations for protecting surgical teams; structure frequent communication before key events; assume the entire operation theater will be contaminated; choose personal protective equipment (PPE) effective against aerosolized particles; adapt surgical technique to reduce exposure risks; use a "buddy system" for donning and doffing; after operation/recovery; going home – what should be done to keep your family safe. Though careful planning and appropriate PPE are essential, the most effective way to prevent viral exposure is to avoid performing non-essential surgical procedures. Non-operative approaches may be a safe alternative to surgery for some patients. Many patients, however, will require emergency operative intervention.

**Keywords:** COVID-19, Personal protective equipment, Aerosols generating procedure, N95 mask, Social distancing

### INTRODUCTION

SARS CoV-2, the virus responsible for coronavirus disease 2019 (COVID-19), has caused a global pandemic that has already infected more than 2 million people worldwide and the number is still rising. Given the baseline rate of emergency operations worldwide, thousands of COVID-19 positive patients are likely to require surgical interventions during this outbreak.<sup>1</sup>

Surgeons' obligation, as always, will be to provide timely, high-quality surgical care that achieves the best outcomes for patients. But if surgical teams are not adequately

protected from virus transmission during the COVID-19 outbreak, our health systems' capacity to provide necessary care will be jeopardised as more clinicians will be forced into quarantine. It is imperative to ensure the safety of health-care workers not only to safeguard continuous patient care but also to ensure they do not transmit the virus further.

In this review, we draw from published literature and clinical experience to highlight key considerations for surgical teams operating on patients with suspected or proven COVID-19.

**Objective**

The objective of this study to review the considerations for optimum surgical team protection before, during and after operation.

**KEY CONSIDERATIONS FOR SURGEONS**

Surgical teams are at uniquely high risk for SARS CoV-2 exposure. Viral particles have been found in nasal swabs, pharyngeal swabs, sputum, bronchial swabs, gastrointestinal tissue, blood, and stool.<sup>2,3</sup> Surfaces in isolation rooms and even clinician shoe covers have tested positive as well.<sup>4,5</sup> Moreover, the virus can spread via aerosols and fomites, and survive as aerosol for at least 3 hours and on surfaces for days.<sup>6</sup> Studies of other viruses have found viral load in essentially all tissues and fluids tested and even surgical smoke from the use of electrocautery.<sup>7,8</sup>

Given these inherent risks, we outline key considerations for protecting surgical teams below.

**Structure frequent communication before key events**

Without detailed planning and protocols, transporting a patient with COVID-19 puts clinicians and patients at high risk of viral transmission. Frequent, structured communication in the form of huddles plays an integral role in mitigating this risk. A recent article described the value of bringing together stakeholders to plan safe patient transport and the process of getting the patient onto the operation theatre table.<sup>9</sup>

Huddles should include surgeons, the anaesthesia team, intensive care unit (ICU) staff and nurses, respiratory therapists, operation theatre (OT) nursing staff, environmental services, security, and members of infection control. To standardize this process, hospitals have developed transport protocols for the operative team and are performing transport simulations to prepare for high numbers of potential patients.<sup>10,11</sup> Open communication between the surgical team and peri-operative staff allows the group to transfer high-risk patients from wards to the OT and back with reduced risk to the team.

**Assume the entire OT will be contaminated**

SARS CoV-2 can survive for days on multiple operation theatre surfaces, including plastic and stainless steel.<sup>6</sup> Under ordinary conditions, operation theatres use positive pressure airflow, but this runs the risk of contaminating adjacent OTs and hallways ; thus, operation theatres with negative pressure capabilities are recommended.<sup>12</sup> When negative pressure rooms are unavailable, it is important to allow sufficient time between cases for complete room air exchange - usually around 30 minutes. This time interval is based on the number of air changes per hour as described by the CDC.<sup>13</sup>

Items such as hospital charts and cell phones must be left outside the OT. Additionally, anything that was in contact with the patient, such as the ward bed, should also be considered contaminated. If possible, a dedicated runner should be posted outside of the OT to obtain supplies such as suture, surgical staplers, and energy devices as needed.<sup>9</sup> This eliminates the need for excessive movement into and out of the room by the circulating nurse, and also minimizes consumption of personal protective equipment (PPE) with every entry and exit of the room. All single-use equipment (even unopened) in the room is thrown away at the end of the case, and thus only what is currently needed and absolutely required for the case should be brought in.

**Choose protective equipment effective against aerosolized particles**

Standard surgical PPE includes a face shield, mask, waterproof gown, double gloves, and shoe covers. There is some disagreement, however, about the type of respiratory protection -- N95 respirator, powered air purifying respirator (PAPR), or standard surgical mask - that should be used for surgical procedures on patients with COVID-19. Currently, we are not aware of data to suggest that either the N95 or PAPR are better to protect against COVID-19. PAPRs are generally used when HCWs cannot achieve a proper fit with an N95; guidelines and mask specifications suggest equivalence for aerosolized agents.<sup>14</sup> A surgical mask is capable of blocking gross inhalation of droplets, while a well-fitted N95 respirator is additionally capable of filtering aerosols. This is of particular interest to surgeons as aerosols have been identified from multiple surgical procedures, including those that use electrocautery and high-speed tools, and smoke from electrocautery has been shown to harbor intact bacterial and virus particles.<sup>7,8,15-19</sup> As such, surgery can be considered a form of “aerosols generating procedure” (AGP), especially with the use of electrocautery and/or laparoscopy.<sup>20</sup>

Patient Care for Patients Not Suspected for COVID-19	Patient Care for Patients Suspected or Positive for COVID-19	Aerosol Generating Procedures <sup>1</sup> on Patients Suspected or Positive for COVID 19 AND Airway Procedures on All Patients
<p><b>WHEN:</b></p> <ul style="list-style-type: none"> <li>• Patient has no COVID symptoms</li> <li>• Closer than 6 feet from patient for more than 1 minute</li> </ul> <p><b>WHERE:</b></p> <ul style="list-style-type: none"> <li>• Ambulatory Clinics</li> <li>• Emergency Department</li> <li>• Acute Care Units</li> <li>• Intensive Care Units</li> <li>• Procedural Areas</li> </ul> <p><b>PPE Required:</b></p> <ul style="list-style-type: none"> <li>• Surgical/ear loop mask</li> </ul>	<p><b>WHEN:</b></p> <ul style="list-style-type: none"> <li>• Patient has COVID symptoms OR has a COVID test pending or with positive result</li> </ul> <p><i>*If interaction requires being within 3 feet of the patient, the patient should also wear a surgical mask*</i></p> <p><b>WHERE:</b></p> <ul style="list-style-type: none"> <li>• Ambulatory Clinics</li> <li>• Emergency Department</li> <li>• Acute Care Units</li> <li>• Intensive Care Units</li> <li>• Procedural Areas</li> </ul> <p><b>PPE Required:</b></p> <ul style="list-style-type: none"> <li>• Eye protection/face shield</li> <li>• Surgical/ear loop mask</li> <li>• Gown</li> <li>• Gloves</li> </ul>	<p><b>WHEN:</b></p> <ul style="list-style-type: none"> <li>• Aerosol generating procedures<sup>1</sup> are being performed</li> </ul> <p><b>WHERE:</b></p> <ul style="list-style-type: none"> <li>• Ambulatory Clinics</li> <li>• Emergency Department</li> <li>• Acute Care Units</li> <li>• Intensive Care Units</li> <li>• Procedural Areas</li> </ul> <p><b>PPE Required:</b></p> <ul style="list-style-type: none"> <li>• PAPR OR N95 Respirator + Face Shield/Eye Protection</li> <li>• Gown</li> <li>• Gloves</li> </ul>
<p><b>Note for all categories shown: Hand hygiene required upon entry and exit, regardless of whether the patient is under isolation, or PPE is worn.</b></p>		

**Figure 1: PPE recommendations.**

***The illustration below provides a schematic for use of PPE***

The centers for disease control in both the US and in China, as well as the association of Spanish surgeons, specifically recommend use of N95 respirators (preferably without valves) for surgeries with AGPs on COVID-19 patients.<sup>21,22</sup> Australia's department of health encourages N95 use for "high-level contact" with infected patients.<sup>23</sup> A recent guideline in the Chinese journal of surgery presented recommendations for emergency surgery in COVID-19 patients that specifically include the use of N95 masks for anaesthesia and surgical teams.<sup>24</sup>

However, the World Health Organization (WHO) recently published PPE guidelines for healthcare workers that did not specify that surgical procedures required N95 respirators.<sup>25</sup> Some groups may erroneously interpret the absence of laparoscopy or electrocautery on the list to imply that most surgical procedures are not aerosol-generating. The meta-analysis cited by the WHO guidelines specifically noted that there were nearly no surgical cases included in its analysis because it focused on tracheal aerosols and only open thoracotomy was extracted as a data element.<sup>26</sup> In a time when there is limited information about transmission of COVID-19, aggressive protection<sup>4</sup> with complete PPE for AGPs (which include N95 masks) is in line with guidance from multiple national organizations as well as the limited data available from previous research.

***Adapt surgical technique to reduce exposure risks***

It is unclear if laparoscopy increases surgeon risk of exposure to aerosolized viral particles. Carbon dioxide insufflation, energy devices, and high-speed surgical equipment generate significant aerosols. Though aerosols may be contained in the abdomen during laparoscopy, when expelled under pressure- such as with release of pneumoperitoneum- they may spread widely.<sup>27,28</sup> Care should be taken to minimize the possibility of inadvertent release and filter the CO<sub>2</sub> using existing technology.<sup>24,29</sup> However, this risk may not be unique to laparoscopy. Viral and bacterial aerosols have been identified in surgical plumes in both laparoscopic and open procedures.<sup>8,15,17,18</sup> However, the use of a smoke evacuation device is in line with pre-existing OT guidelines and may reduce aerosol exposure in both open and laparoscopic procedures.<sup>30</sup> In the absence of convincing data, when both open and laparoscopic approaches are clinically appropriate, the safest approach may be the one that is most familiar to the surgeon and reduces operative time.

***Use a "buddy system" for donning and doffing***

Clinicians may actually be more likely to infect themselves when removing their PPE than when caring for a contagious patient.<sup>31</sup> To avoid self-contamination, everyone in the OT must be able to put on (don) and remove (doff) PPE correctly. Proper donning and doffing

procedures should be reviewed with surgeons, residents, and OT staff before each case to ensure proper technique.<sup>32,33</sup> In addition, based on previous viral outbreaks, a "buddy system" has been recommended, in which providers assist with and oversee the doffing of a colleague.<sup>34</sup> In our experience, the combined use of video based instruction and a colleague's oversight significantly improves anxiety among staff and may lead to less self-contamination during PPE removal.

***After operation/recovery***

If transport of a patient with or suspected to have COVID-19 infection to an outside recovery area or intensive care unit is necessary, handoff to a minimum number of transport personnel who are waiting outside the operating room should be considered. Personnel should wear personal protective equipment that should not be the same as worn during the procedure. Recommendations for surgeon protection before and after separating from a patient with or suspected of having COVID-19 infection vary from institution to institution. Remove clothes worn from home and keep in garment bag. Wear scrub clothes after arrival at hospital. After separating from the patient remove scrub clothes; consider showering before changing into a clean scrub suit or home clothes. Wash hands frequently and maintain safe social distancing.<sup>35-37</sup>

***Going home - what should be done to keep your family safe***

Healthcare institutions and systems may make hotel accommodations available for healthcare workers who cannot or prefer not to go home following patient care activities. Be alert to the fact that viral contamination of surfaces is a known means of transmission of infection. Keep hand sanitizer and/or disposable gloves for use of ATM, vending machines, gasoline pumps, and transfer of items at the time of purchases. Clean your cell phone frequently before, during, and after patient care activities. Cell phones may be kept in a Ziploc bag during work activities. The phone can be used while in the bag. Consider removing clothes and washing them upon arrival home. Consider reducing physical contact with family members and wash hands frequently. Clean hard surfaces at home with an effective disinfectant solution (e.g. 60% alcohol).<sup>37</sup>

**CONCLUSION**

Though careful planning and appropriate PPE are essential, the most effective way to prevent viral exposure is to avoid performing non-essential surgical procedures. As recommended by the American college of surgeons, this limits the opportunities for patients and clinicians to become exposed, conserves personal protective equipment, and preserves health system capacity. Non-operative approaches (e.g. for appendicitis, diverticulitis, and cholecystitis) may be a safe alternative to surgery for

some patients. Many patients, however, will require emergency operative intervention.

Our evaluation of the literature has provided more questions than answers with regard to PPE choices and surgical technique. Recent clinical trials have focused on outpatient clinicians, but no study has effectively evaluated how best to protect operating surgeons. As we better understand the epidemiology of transmission of these agents and methods of prevention, there is a need to study and re-evaluate the information above.

Thus, the issues highlighted in this review should not be taken as official guidelines, mandates, or standard operating procedures. The global community is continuously learning about COVID-19 every day. Surgeons should seek guidance from their appropriate national, local, and hospital guidelines and regulations - many of which are likely to change over time as new information becomes available to the global community.

By presenting our best understanding of the literature, we are hoping to promote the safety of surgical teams and, as a result, the patients who are relying on them for life saving surgical care.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: Not required*

## REFERENCES

- Gale SC, Shafi S, Dombrowskiy VY. The public health burden of emergency general surgery in the United States: A 10 years analysis of the Nationwide Inpatient Sample - 2001 to 2010. *J Trauma Acute Care Surg.* 2014;77:202-8.
- Wang W, Xu Y, Gao R. Detection of SARS - CoV-2 in Different Types of Clinical Specimens. *JAMA.* 2020;323(18):1843-1844.
- Guan WJ, Ni ZY, Hu Y. Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med.* 2020;382:1708-20.
- Chang D, Xu H, Rebaza A. Protecting health - care workers from sub-clinical coronavirus infection. *Lancet Respir Med.* 2020;8:13.
- Ong SWX, Tan YK, Chia PY. Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS - CoV-2) From a Symptomatic Patient. *JAMA.* 2020;323(16):1610-2.
- Doremalen VN, Bushmaker T, Morris DH. Aerosol and Surface Stability of SARS - CoV-2 as compared with SARS - CoV-1. *N Engl J Med.* 2020;382(16):1564-7.
- Kwak HD, Kim SH, Seo YS. Detecting hepatitis B virus in surgical smoke emitted during laparoscopic surgery. *Occup Environ Med.* 2016;73:857-63.
- Stephenson DJ, Allcott DA, Koch M. The presence of P22 bacteriophage in electrocautery aerosols. In: *Proceedings of the National Occupational Research Agenda Symposium, Salt Lake City, UT.* Available at: [https://www.researchgate.net/profile/Dale\\_Stephenson/publication/242419093\\_the\\_presence\\_of\\_p22\\_bacteriophage\\_in\\_electrocautery\\_aerosols/links/00b7d52a09d15f05f3000000.pdf](https://www.researchgate.net/profile/Dale_Stephenson/publication/242419093_the_presence_of_p22_bacteriophage_in_electrocautery_aerosols/links/00b7d52a09d15f05f3000000.pdf). Accessed on 18 March 2020.
- Ti LK, Ang LS, Foong TW. What we do when a COVID - 19 patient needs an operation: operating room preparation and guidance. *Can J Anaesth.* 2020;67(6):756-8.
- UW Medicine COVID-19 Protocols Available at: <https://covid-19.uwmedicine.org/Pages/default.aspx>. Accessed on 19 March 2020.
- UCSF Health COVID - 19 Clinical Resources | UCSF Health Hospital Epidemiology and Infection Prevention. Available at: <https://infectioncontrol.ucs-fmedicalcenter.org/coronavirus>. Accessed on 19 March 2020.
- Wax RS, Christian MD. Practical recommendations for critical care and anaesthesiology teams caring for novel coronavirus (2019 - nCoV) patients. *Can J Anaesth.* 2020;67:568-76.
- Air Appendix Environmental Guidelines, Guidelines Library, Infection Control, CDC. Available at: <https://www.cdc.gov/infectioncontrol/guidelines/environmental/appendix/air.html>. Accessed on 20 March 2020.
- Qian Y, Willeke K, Grinshpu SA. Performance of N95 respirators: filtration efficiency for airborne microbial and inert particles. *Am Ind Hyg Assoc J.* 1998;59:128-32.
- Farmer WM, Nataupsky M, Gorochovskaia R. Identification of Aerosol Production during Surgical Procedures. 00229128; NIOSH. Available at: <https://www.cdc.gov/niosh/nioshtic-2/00229128.html>. Accessed on 18 March 2020.
- Tream IC. Aerosol Generating Procedures (AGPs). Health Protection Scotland. Available at: [https://hpspubsrepo.blob.core.windows.net/hps-website/nss/2893/documents/1\\_tbp-1r-agp-v1.pdf](https://hpspubsrepo.blob.core.windows.net/hps-website/nss/2893/documents/1_tbp-1r-agp-v1.pdf). Accessed on 23 November 2019.
- Mellor G, Hutchinson M. Is it time for a more systematic approach to the hazards of surgical smoke: reconsidering the evidence. *Workplace Health Saf.* 2013;61:265-70.
- Schultz L. Can Efficient Smoke Evacuation Limit Aerosolization of Bacteria. *AORN J.* 2015;102:7-14.
- Liu Y, Song Y, Hu X. Awareness of surgical smoke hazards and enhancement of surgical smoke prevention among the gynecologists. *J Cancer.* 2019;10:2788-99.
- CDC. Coronavirus Disease 2019 (COVID - 19). Centers for Disease Control and Prevention. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirator-use-faq.html>. 2020. Accessed on 18 March 2020.
- For different groups of people: how to choose masks. Available at: [http://en.nhc.gov.cn/2020-02/07/c\\_76344\\_2.htm](http://en.nhc.gov.cn/2020-02/07/c_76344_2.htm). Accessed on 18 March 2020.

22. Recomendaciones para manejo de pacientes con infección por Covid-19 en el contexto de una intervención quirúrgica urgente O electiva. Asociación Española de Cirujanos (AEC). Available at [https://www.aecirujanos.es/files/noticias/152/documentos/Recomendaciones\\_caso\\_cirugia.pdf](https://www.aecirujanos.es/files/noticias/152/documentos/Recomendaciones_caso_cirugia.pdf). Accessed on 18 March 2020.
23. Australian Health Department. Interim recommendations for the use of PPE during hospital care of people with COVID-19 Version 2. Available at: <https://www.health.gov.au/sites/default/files/documents/2020/03/interim-recommendations-for-the-use-of-personal-protective-equipment-ppe-during-hospital-care-of-people-with-coronavirus-disease-2019-covid-19.pdf>. Accessed on 18 March 2020.
24. Kaixiong T, Bixiang Z, Peng Z. Recommendations for general surgery clinical practice in novel coronavirus pneumonia situation. *Chinese J Surg.* 2020;58:E001.
25. World Health Organization. Rational use of personal protective equipment for coronavirus disease 2019 (COVID-19): Interim Guidance. WHO/2019-nCov/IPC\_PPE\_use/2020.1; WHO. Available at [https://apps.who.int/iris/bitstream/handle/10665/331215/WHO-2019-nCov-IPCPE\\_use-2020.1-eng.pdf](https://apps.who.int/iris/bitstream/handle/10665/331215/WHO-2019-nCov-IPCPE_use-2020.1-eng.pdf). Accessed on 18 March 2020.
26. Tran K, Cimon K, Severn M. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. *PLoS One.* 2012;7:35797.
27. Coteaux DJG, Picard P, Poulin EC. Preliminary study of electrocautery smoke particles produced in vitro and during laparoscopic procedures. *Surg Endosc.* 1996;10:152-8.
28. Li CI, Pai JY, Chen CH. Characterization of smoke generated during the use of surgical knife in laparotomy surgeries. *J Air Waste Manag Assoc.* 2020;70:324-32.
29. Yu GY, Lou Z, Zhang W. Several suggestions of operation for colorectal cancer under the outbreak of Corona Virus Disease 19 in China. *Zhonghua Wei Chang Wai Ke Za Zhi.* 2020;23:9-11.
30. Ball K. Compliance with surgical smoke evacuation guidelines: implications for practice. *ORNAC J.* 2012;30:14-6.
31. Moore D, Gamage B, Bryce E. Protecting health care workers from SARS and other respiratory pathogens: organizational and individual factors that affect adherence to infection control guidelines. *Am J Infect Control.* 2005;33:88-96.
32. Centers for Disease Control. Sequence for putting on personal protective equipment (PPE). Available at: <https://www.cdc.gov/hai/pdfs/ppe/ppe-sequence.pdf>.
33. COVID-19: Removal and disposal of Personal Protective Equipment (PPE). UK: NHS. Available at <https://youtu.be/oUo5O1JmLH0>. Accessed on 19 March 2020.
34. NIOSH. NIOSH Fact Sheet: The Buddy System. Available at: <https://www.cdc.gov/vhf/ebola/pdf/buddy/system.pdf>. Accessed on 18 March 2020.
35. COVID-19: Guidance for Triage of Non-emergent Surgical Procedures. American College of Surgeons. Available at <https://www.facs.org/about-ACS/covid-19/information-for-surgeons/triage>. Accessed on 19 March 2020.
36. Radonovich LJ, Simberkoff MS, Bessesen MT. N95 Respirators vs Medical Masks for Preventing Influenza Among Health Care Personnel: A Randomized Clinical Trial. *JAMA.* 2019;322:824-33.
37. American College of Surgeons: COVID-19: Considerations for Optimum Surgeon Protection. 2020. Available at: <https://www.facs.org/covid-19/clinical-guidance/surgeon-protection>. Accessed on 15 April 2020.

**Cite this article as:** Punia G, Kharb S, Gulia A, Bansal S, Chandan S, Kumar M. COVID-19: considerations for optimum surgical team protection before, during and after operation. *Int J Res Orthop* 2020;6:868-72.