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COVID-19 and laparoscopic surgery, a scoping review of current literature and local expertise.

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Abstract

Background: The current COVID19 pandemic is holding the world in its grip. Epidemiologist has shown that the mortality risks are higher when the health care system falls under the COVID19 pressure. It is, therefore, of great importance to keep health care providers (HCP) healthy and prevent contamination. An important group who will be confronted with the treatment of COVID19 positive patients are HCP during (semi) acute surgery. There are concerns that laparoscopic surgery increases the risk of contamination more than open surgery, therefore balancing the safety of HCP with the benefit of laparoscopic surgery for the patient.

Objective: To provide an overview of potential contamination routes, possible risks for HCP, and propose research questions based on current literature and expert opinions about laparoscopic surgery on a COVID19 positive patient.

Methods: We performed a scoping review adding five additional questions concerning possible contaminating routes. A systematic search was performed on Pubmed, CINAHL, and Embase databases adding results from gray literature as well. The search was not only for COVID-19 but extended with virus contamination in general. We excluded society and professional association statements about COVID-19 if they did not add new insights into the available literature.

Results: The initial search provide 2.007 records, after which 267 full-text papers were considered. Finally, we used 84 papers of which 14 were discussing SARS-CoV-2. Eight papers discuss the added value of performing intubation in a low-pressure operating room, mainly based on the SARS outbreak experience from 2003. Thirteen papers elaborate on the risks of intubation for the HCP and SARS-CoV-2 and 19 papers discuss this situation with other viruses. They conclude that there is significant evidence that in- and extubation is a high-risk aerosol producing procedure. No papers were found on the risk of SARS-CoV-2 and surgical smoke, although 25 papers did provide conflicting evidence on the infection risk of HPV, hepatitis B, polio, and rabies. There were no papers found discussing tissue extraction or the deflation risk of the pneumoperitoneum after laparoscopic surgery.

Conclusions: There seems to be consensus in the literature that in- and extubation is a high-risk procedure for the HCP and that maximum protective equipment is needed. On the other hand, minimal evidence is available discussing the actual risk of contamination of the HCP during laparoscopy itself. Neither on operating room pressure, surgical smoke, tissue extraction, nor CO2 deflation. But there are new studies published daily from current experiences and society statements are continuously updated. There seems no reason to abandon laparoscopic surgery over open surgery. But do not underestimate the risks, perform surgery on COVID-19 positive patients only when necessary, and keep using logical and common sense to protect yourself and others by performing surgery in a safe and protected environment.

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Conclusion: There seems to be consensus in the literature that in- and extubation is a high-risk procedure for the HCP and that maximum protective equipment is needed. On the other hand, minimal evidence is available discussing the actual risk of contamination of the HCP during laparoscopy itself. Neither on operating room pressure, surgical smoke, tissue extraction, nor CO2 deflation. But there are new studies published daily from current experiences and society statements are continuously updated. There seems no reason to abandon laparoscopic surgery over open surgery. But do not underestimate the risks, perform surgery on COVID-19 positive patients only when necessary, and keep using logical and common sense to protect yourself and others by performing surgery in a safe and protected environment.

Keywords: Laparoscopy [MeSH], COVID-19 [MeSH], Surgical Procedures, Operative [MeHS]

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Introduction

The coronavirus disease 2019 (COVID-19) is spreading all over the world and keeps all health care workers in its grip (1). At the moment of writing, the World Health Organization estimated over 2,5 million confirmed cases of COVID-19 and over 175 thousand deaths (2). It is estimated from the Chinees outbreak, that the risk of death is as high as 12% in the epicenter of the epidemic and as low as 1% in the less severely affected areas. This big difference might be due to a breakdown of the healthcare system in the epicenter, enhanced public health interventions, and enhanced hygienic measures (3).

According to Médecins Sans Frontières (MSF) nearly 1700 healthcare providers (HCP), or eight percent of the total COVID-19 cases in Italy, are have been infected, despite all preventive measurements (4). This makes HCP the highest risk group for infection, severe illness and Intensive Care (IC) admission. They stress the incredible importance of protecting this group.

The combination of increased risk of individual infection and the effect of a breakdown of the healthcare system makes it even more relevant to discuss how we can properly protect HCP. If no personal protective equipment is available, it will jeopardize the health care workers (5, 6). Moreover, the shortage of supplies is forcing management to make difficult decisions; where should the supplies go to and who needs them the most in a hospital.

So, who is at risk? According to the American Center for Disease Control, all HCP that are in direct contact with infectious secretions from a patient with COVID-19. As for now, secretions at risk for viral transmission include sputum, serum, blood, feces, and especially respiratory droplets (7, 8). These HCP are all recommended to wear Personal Protective Equipment (PPE). The risk increases

with exposure to aerosol-generating procedures for at least 10 minutes at a distance of fewer than two meters from the patient (9). Studies have shown that procedures such as endotracheal intubation, extubation, noninvasive ventilation, and exposure to aerosols in an open circuit are associated with a high risk of viral transmission. Guidelines about the needed PPE in these situations are getting more and more attention (10).

According to Wong et al, the main risk groups in the operating theatre are those who cannot cancel or delay elective procedures. Foremost, of course, the anesthesiologist, but also departments like intervention radiology, obstetrics, and cardiothoracic surgery (11). Many acute surgical interventions are done by laparoscopy, yet very little is written about the risks for the HCP of laparoscopic surgery in a COVID-19 positive patient. There is a debate in literature discussing whether open surgery might be saver for the HCP compared to laparoscopic surgery (12, 13).

The objective of this study is to provide an overview of potential contamination routes, possible risks for HCP, and propose research questions based on current literature and expert opinions about laparoscopic surgery on a COVID19 positive patient.

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Theoretical contamination routes during laparoscopic surgery

Before we can elaborate on the theoretical contamination routes, we must first discuss the contamination agents. You can divide the agents of contamination into three groups: First those with proven infectious transmission; droplets, close contact and aerosol transmission (14), second those with proven RNA presence, but no proven contamination yet like feces, inanimate surfaces and blood (8, 15, 16) and thirdly unknown or highly debated agents or even the presence of RNA, like urine and amniotic fluid (8). Keep in mind that many studies are undergoing trying to determine which of these agents are apart from having virus RNA present, are also infectious. Taking these agents into regard, there are several theoretical contaminations routes by which the HCP can get infected by a COVID-19 positive patient.

The first and most discussed contamination route is intubation and extubation (17). At this moment the patient is will excrete the most virulent respiratory secretions. The second risk is smoke and air evacuation during surgery (18). During laparoscopy smoke and aerosols are generated, not only for cauterization of blood vessels but also for dissection. This smoke can contain virulent DNA and/or RNA and is sometimes evacuated straight into the over-pressured OR by opening a valve on a trocar. The third contamination moment is tissue extraction (19). Removing tissue, such as an appendix, bowel segments, gallbladder, cysts, ectopic pregnancy etcetera, can cause excretions to be expelled from the body, with the higher abdominal pressure from the laparoscopy creating aerosols from any excretion like blood and mucus. The fourth moment at risk for contamination is at the end of the surgery when the abdominal pressure is released by de-sufflation (19). Releasing all the air, possibly filled with virulent DNA and/or RNA, into the air of the OR, usually under a relatively high pressure. A fifth risk factor can be the OR positive air pressure, pushing aerosols out of the OR into the hallways and other ORs (17).

Methods

To provide an insight into the possible risks of the above-mentioned contaminating routes, we believe a scoping review is most suited. A scoping review allows a broader search and answering multiple questions, while still performing a systematic search(20). Because we expected small results from a search on COVID-19 and laparoscopy, we performed five additional searches for the contamination route and viruses in general.

Systematic search

The literature search was performed on the 24th of April 2020, searching Pubmed, CINAHL, and Embase databases. We then added gray literature from google scholar and local expertise and handbooks from the authors themselves from China, Italy, Spain, the United Kingdom, and the Netherlands. The search string can be found in Appendix A. The five additional questions were:

1) What is the effect of operating room pressure on the contamination risk of COVID-19?
2) What is known about the additional risk during intubation and extubation?
3) Does smoke evacuation during laparoscopic surgery increase the risk of the spread of COVID-19 particles?
4) Is there anything known about tissue extraction during laparoscopic surgery with a COVID-19 positive patient?
5) Does de-sufflation of the abdomen after laparoscopic surgery create airborne aerosols that endanger the HCP?

Inclusion criteria

Types of studies included were trials, reviews, case studies or series, as well as other descriptive

studies concerning the contamination of HCP during (laparoscopic) surgery in the operating theater. We included expert opinions if they added additional insight to the current literature as well.

Exclusion criteria

We excluded society and professional association statements about COVID19, if they did not add any new information. We did use them to snowball their references. We also excluded comments like letters to the editor and papers not written in English.

Study selection

Working independently and in duplicate, reviewers RDL and NB screened all records titles and abstracts. Potentially eligible abstracts and abstracts with disagreement or insufficient information were screened in full text. Disagreements were handled by discussion over the full text.

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Results

The initial search identified 2.007 records of which 59 concerned COVID-19. After excluding 1.740 records based on their title and abstract, we assessed 267 full-text papers for eligibility. Papers were excluded because they were discussing a treatment therapy or diagnostic method (n = 118), did not provide any new information (society statements, letter to the editors and others) (n = 30), were not related to our question after all (n = 12) or were not available in English (n = 9). After hand-searching the papers and society statements we ended up with 60 papers for this review. Of these 60 papers, 21 papers concerned COVID-19, and 39 papers discussed our questions in regards to other viral transmissions. We will now discuss the results for each of the five proposed questions.

1) What is the effect of operating room pressure on the contamination risk of COVID-19?

We found eight papers discussing the effect of operating room safety and the spread of virus DNA. Only one paper actually discussed the Wuhan experience on COVID-19 (11) and all studies are based on theoretical risks (see table 1).

An operating room (OR) with a negative pressure environment is ideal to reduce the dissemination of the virus avoiding air to escape the OR (11). Both the Society of American Gastrointestinal and Endoscopic Surgeons (SAGAS) and the American Society of Gastrointestinal Endoscopy (ASGE) advices surgery to take place in such a negative pressure OR (21, 22). But a standard OR is usually designed to be at positive pressure relative to the surrounding air. Tien et al describe that during the SARS outbreak, surgical procedures were performed within airborne isolation Intensive Care Unit (ICU) rooms and with additional PPE precautions. This eliminated the risk of intra-facility transport and avoided the need to make environmental modifications in the operating room (23). Other papers discuss the same contamination route with SARS and MERS (24-27). Beasley et al discussed

even more isolation strategies in case of surgery on patients with smallpox (28).

In Singapore, they have dedicated separate ORs for surgery in COVID-19 positive patients have been installed. The aim was to reduce the risk of contamination of other ORs and patients. Each OR had its own ventilation system with an integrated high-efficiency particulate air (HEPA) filter. Traffic and flow of contaminated air were minimized by locking all doors to the OR during surgery, with only one possible route for entry/exit via the scrub room (11).

Wax et all provide us with practical recommendations to decrease the viral spread when managing a patient infected with COVID-19 (29). Their advice is to convert operating rooms to negative pressure environments with airflow changes.

2) What is known about the additional risk during intubation and extubation?

Thirteen papers were found discussing in- and extubation with COVID19 positive patients (see table 2). Another 19 papers discuss the risk of intubation for HCP and other viruses then SARS-CoV-2 (see appendix B).

Two reviews (from Cook et al (30) and Wax et al (29)) provide a great overview of current knowledge and stress the increased risk of HCP during in- and extubation. A case series van Heinzerling shows that 3 of 121 HCP tested positive after (assisting) intubation (31).

Zucco at al warns that the anesthesia professional and intensivist have the highest risk of exposure to respiratory droplets during intubation and extubation (32). They provide a 10-point list of precautions that should be taken into account when intubating or extubating COVID-19 positive patients (33). Again, Wax et all advice high-risk aerosol-generating procedures, such as intubation,

not be performed in a positive pressure environment (29). Won et al advice to use at least NIOSH-certified N95 respirator, eye protection (either goggles or full-face shield), cap, gown, and gloves. As transmission remains possible despite N95 protection, staff participating in aerosol-generating procedures can wear a PAPR (11). Repici et al suggests additional PPE during endoscopic procedures but does not provide additional insight into the risks of intubation (34).

Learning from other experiences, 16 studies stress the increased risk for HCP during intubation from the 2003 SARS period (see appendix B). Pei et al show an odds ratio (OR) for a HCP to be infected of 30,8 (27). And while others show lower numbers (Rabout et al 2.79 (35) and Tran et al 6.6 (36)), they all label intubation as a very high-risk procedure for the HCP.

3) Does smoke evacuation during laparoscopic surgery increase the risk of the spread of COVID-19 particles?

We found 25 papers discussing the effect of surgical smoke on an HCP. But none of these is specific for COVID-19. A review from Mowbay et al from 2013 included 20 studies showing the diverse outcomes of these studies and conclude that infective virus DNA can be found in the smoke plume, but the risk to theater staff is unproven (37). We found 19 studies not mentioned in the Mowbay review (see table 3), also showing a diversity in results. Kwak et al from Korea in find hepatitis B DNA in 10 of 11 cases (38), but Waynandt did not find any Human Papilloma Virus (HPV) in 28 cases of CO2 laser plume (39). Another study, on the other hand, shows that laparoscopic surgery is associated with better preservation of the immune system than open surgery. This results in a decreased incidence of infectious complications (40). A systematic review concerning surgical smoke during open surgery shows that in terms of infection risk, 6 (30 %) of the 20 studies assessed surgical smoke for the presence of viruses, with only 1 study (5 %) positively identifying viral DNA in

laser-derived smoke (37). This has been shown for HPV DNA (41, 42).

4) Is there anything known about tissue extraction during laparoscopic surgery with a COVID-19 positive patient?

There were no studies found concerning this subject. The only studies that were found concerned malignant cells, but those were left out of the scope of this review. One study showed that during laparoscopic surgery, still 48,5% of surgeon's masks, 29,5% of assisting surgeons masks, and 31,8% of scrub nurses masks were positive for either visible of visually enhance blood contamination (43). This demonstrates that wearing masks is of great importance, even when performing laparoscopic surgery.

5) Does de-sufflation of the abdomen after laparoscopic surgery create airborne aerosols that endanger the HCP?

There was one study discussing the desufflatie of CO2 gas used during laparoscopic, rectal surgery in a case study (44). The SAGES recently stated that there is a good possibility of viral contamination during laparoscopy and, "While it is unknown whether coronavirus shares these properties, it has been established that other viruses can be released during laparoscopy with carbon dioxide." Although this only been shown in smoke, not clear CO2 (45).

In one study the effect of the COVID19 on the strategy for colorectal cancer patients is discussed. The authors recommend that especially NOSES and TaTME should be carried out with caution during the epidemic period since fecal-oral transmission and aerosol transmission during this kind of surgery have not been excluded. A protective stoma should reasonably be carried out, and the protection of operating room personnel should be strengthened (46).

Discussion

There is quite some existential consensus in literature that in- and extubation are high-risk procedures for the HCP. Studies have shown an odds ratio as high as 30, stressing the importance of proper PPE during those procedures (27). Literature suggests that in- and extubation should preferably be done in a low-pressure environment with protective gear for the HCP. A reasonable amount of studies show that surgical smoke does contain viral DNA and inhalation by the HCP should be avoided. The infectiousness of tissue extraction and the insufflation gas itself is absolutely unknown and all advice is at least “arguable” (see table 5).

When current knowledge does not help us any further, we are faced with a dilemma. Should we go for the conservative route and provide extensive PPE and prevent surgery at all costs? This might sound as the safe way to go, but performing surgery wearing a PAPR (11) might not even be possible. In addition, delaying surgery might cause a patient more harm due to disease progression. Also, as COVID-19 keeps spreading, resources are getting low and it might not be possible to provide each HCP with the proper PPE. In that case, we should start to distribute resources where they are needed most, but also where the evidence provides insight into its effectiveness.

The Handbook of COVID-19 Prevention and Treatment – compiled by the first affiliated Hospital, Zehjang University School of Medicine (47) might not be peer-reviewed and published but does provide important lessons from previous outbreaks. They consider any kind of surgery to be high risk and advise level III protection during surgery (which means surgical cap, N95 protective mask, work uniform, disposable medical protective uniform, disposable latex gloves and a full-face respiratory device of powered air-purifying respirator), negative pressure operating rooms and

several other hygiene precautions (47).

Please find a summary of our recommendations in table 4.

Comparing open surgery with laparoscopic surgery

Surgery cannot always be avoided or delayed. Should we then instead of laparoscopic surgery, perform open surgery? Evidence has shown the benefits of laparoscopic surgery in many cases and for multiple indications. Should we abandon these benefits for the patient in favor of lowering the risks for HCP? The risks related to the increased OR pressure and intubation are not changed during open surgery. The smoke evacuation might be even better controlled by laparoscopy then open surgery and the effect of tissue extraction and de-sufflation is completely unknown. The cauterization might be comparable, but dissection by sharp instruments as scissors and using ligatures to prevent bleeding is more often used during open surgery. Blood splash risks are estimated to be at 48,5% (43) in laparoscopy and 45% in open surgery (48). Northern Italian surgeons prefer laparoscopy over laparotomy, making a case for a more controlled splatter and smoke environment. To the opinion, there is no reason to perform open surgery where laparoscopy is the first choice (49).

Preventive measurements

All studies emphasize the importance of protecting the HCP with adequate PPE, whether they are performing surgery of a physical exam. Although there is a diverse interpretation of how to use PPE. There are many studies examining, for example, face masks (50-52). The debate is focused on the added value of giving the patient a mask (51), or which mask to use (52, 53). Some studies provide hospital-made protective gear solutions in case of limited resources (54) or show the added value of

salt-covered masks (55). Finally, there are studies that show trans ocular infection of influence, advising N95 protective gear for the eyes are well (56).

Focusing on the other contamination routes, Hahn et al showed that a build-in-filter trocar removes > 60% of hazardous molecules during laparoscopic rectal resection, and companies are registering these trocars (57). The SAGAS and other advised; use of devices to filter released CO2 for aerosolized particles should be strongly considered and turn off the OR high pressure or even better, create low pressures ORs. Create a few dedicated ORs for the purpose of emergency surgery on COVID-19 positive (or high risk) patients.

Think logical about tissue extraction, protect yourself and the OR staff, first de-sufflate the abdomen, and don't hesitate to increase the incision a little bit rather than increasing the risk on the spread of aerosols. Finally, when de-sufflating, consider a filter or use the same system as the smoke evacuation.

To conclude we would like to look forward. There is an ongoing debate on the pre-operative screening of asymptomatic patients and how to proceed when the peak of the crisis is over and we can start elective surgery again. To screen for asymptomatic COVID-19 patients, earlier SARS-CoV-2 outbreak studies show a higher sensitivity from a computerized tomography scan (CT-scan) compared to PCR swap (58, 59). Yet more recent studies debate the actual added value in absolute numbers and the risks of false-positive outcomes even when using new classification systems (60, 61). Upcoming studies are needed to properly advise about COVID-19 screening. Most of all; use logical and common sense to protect yourself and others by performing surgery in a safe and protected environment. A global effort is taken to report on the experience and outcomes of COVID-

19 surgical patients. For the study protocol, registration, and details, please go to globalsurg.org/covidsurg/.

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List of abbreviations

COVID-19	coronavirus disease 2019
MSF	Doctors Without Borders
HCP	healthcare providers
HPV	human papilloma virus
IC	Intensive Care
PPE	Personal Protective Equipment
OR	operating rooms
SAGAS	Society of American Gastrointestinal and Endoscopic Surgeons
ASGE	American Society of Gastrointestinal Endoscopy
ICU	Intensive Care Unit
HEPA	integrated high-efficiency particulate air (HEPA) filter
HBV	Hepatitis B Virus
CT-scan	computerized tomography scan

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Declarations

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Table 1 – literature concerning operating room and viral transmission

Study / Country	Design	Period of evaluation	Pathogen of evaluation	Study quality (GRADE)
Zhao et al (62) China	retrospective cohort	Wuhan 2020	SARS-Cov-2	low
Pei et al (27) China	case-control study	Peking 2003	SARS	low
Kamming et al (25) Canada	experience paper	Toronto 2003	SARS	low
Chee et al (24) Sinigapore	experience paper	Singapore 2003	SARS	low
Tien et al (23) Canada	Case series	Toronto 2003	SARS	low
Park et al (26) South Korea	Experience paper	Sungkyunjkwan 2015	MERS	low
Beasley et al (28) United States	Opinion paper	Washington 2004	Small pox	low
Santos de Silva et al (63) Brazil	case report	Vale dos Sinos 2014	Adenovirus	low

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Table 2 – literature concerning intubation and SARS-CoV-2 virus

Study / Region	Design	Pathogen of evaluation	Period of evaluation	Main result / topic
Cook (30) U.K.	narrative review	SARS-CoV-2	2020	purpose and use of PPE
Wax (29)	review	SARS-CoV-2	2020	anesthesia guidelines
Heinzerling (31) U.S.A.	case series	SARS-CoV-2	2020	3 of 121 HCP tested positive
Meng (64) China	experience paper	SARS-CoV-2	2020	29% of hospitalized COVID19 patients were HCP
Sorbello (65) Italy	experience paper	SARS-CoV-2	2020	high level PPE. For aerosolgenerating procedures
Yao (66) China	experience paper	SARS-CoV-2	2020	anesthesia advice for intubation
Zhao (62) China	retrospective cohort	SARS-CoV-2	2020	Anesthetic management guidelines
Zuo (67) China	experience paper	SARS-CoV-2	2020	Anesthesia guideline
Giwa (68) Italy	experience paper	SARS-CoV-2	2020	complete COVID19 overview
Greenland (69) U.S.A.	review	SARS-CoV-2	2020	intubation advice
Kim (70) South Korea	expert opinion	SARS-CoV-2	2020	anesthesia advice
Au Yong (71) Singapore	experience paper	SARS-CoV-2	2020	intubation advice
Zhang (72) China	case series	SARS-CoV-2	2020	no HCP infected

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Table 3 – literature concerning surgical smoke and plume

Study / Country	Design	Pathogen of evaluation	Typ of smoke	Positive results
Mowbray et al 2013 (37)	systematic review	HPV, compounds cells, particles	diathermy, laser ultrasonic-derived smoke	20 studies included
Subbarayan et al (73) U.S.A. 2019	case series	HPV16	laparoscopic electrosurgery	0 of 6 cases
Neumann et al (74) Germany 2017	prospective pilot serie	HPV	Loop electrosurgical excision procedures	4 of 24 cases
Dodhia et al (75) U.S.A. 2017	case series	HPV	KTP laser	0 of 12 fibers
Kashima et al (76) U.S.A. 2016	case series	HPV	CO2 laser	17 of 30 cases
Garden et al (77) U.S.A. 2015	animal study	papillomavirus	CO2 laser	3 of 3 cases
Kwak et al (38) Korea 2014	case series	Hep B	laparoscopic electrosurgery	10 of 11 cases
Manson (78) U.S.A. 2013	review	HPV	CO2 laser	4 studies included
Weynandt et al (39) Germany 2010	case series	HPV	CO2 laser, argon plasma	0 of 28 cases
Taravella et al (79) U.S.A. 1998	experiment	polio virus	excimer laser	2 of 2 cases
Hughes et al (80) U.S.A. 1997	case series	HPV	erbium YAG laser	0 of 5 cases
Hagen et al (81) U.S.A. 1997	experiment	pseudorabies virus	excimer laser	0 of 20 cases
Gloster et al (82) U.S.A. 1995	survey cohort study	HPV	CO2 laser	31 of 570 reports
Jewett et al (83) U.S.A. 1992	experiment	Hemoglobine	drill aerosols	5 of 5 cases

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Starr et al (84) U.S.A. 1992	experiment	Simian Immuno-deficiency virus	CO2 laser	0 of 5 cases
Baggish et al (41) U.S.A. 1991	case series	HIV	CO2 laser	0 of 12 cases
Hallmo et al (85) Norway 1990	case report	HPV	erbium YAG laser	1 of 1 cases
Andre et al (86) France 1990	Case report	HPV	CO2 laser	2 of 2 cases
Sawchuk et al (87) U.S.A. 1988	case series	HPV	Co2 laser	4 of 8 cases
Bellina et al (88) U.S.A. 1982	experiment	HPV	CO2 laser	no viable virus

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Table 4 - Care advise for laparoscopic surgery

Care advise for laparoscopic surgery
Postpone elective surgery
Consider screening every patient that needs emergency surgery for COVID-19 by either PCR swab or CT-scan of the thorax
Dedicate specific ORs to COVID-19 positive patients
Turn off positive pressure / create negative pressure ORs
  Use level III personal protective equipment during in, - and extubation
Consider level III PPE but at least adequate mouth, face and eye protection during surgery
Use proper filter and closed system for smoke evacuation
Use proper filter and preferred closed system for CO2 de-sufflation
No trans anal surgery
Consider faces as contaminated fluids

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Table 5 – an overview of the proposed questions and it's evidence

Transmission route	Available evidence	Advice
Positive pressure OR	minimal	turn off positive pressure, prepare several negative pressure ORs
Intubation / extubation	minimal	level III protection, should not be performed in positive pressure OR
Smoke evacuation	minimal	use proper filter in a closed vacuum system
Tissue extraction	none	use at least masks and screens / goggles
De-sufflation abdomen	none	use a proper filter, preferred into a closed system

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