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SAGES GUIDELINES

SAGES 2022 guidelines regarding the use of laparoscopy in the era of COVID-19

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Abstract

Background SARS-CoV-2 has changed global healthcare since the pandemic began in 2020. The safety of minimally invasive surgery (MIS) utilizing insufflation from the standpoint of safety to the operating room personnel is currently being explored. The aims of this guideline are to examine the existing evidence to provide guidance regarding MIS for the patient with, or suspecting of having, the SARS-CoV-2 as well as the healthcare team involved.

Methods Systematic literature reviews were conducted for 2 key questions (KQ) regarding the safety of MIS in the setting of COVID-19 pandemic. Reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis criteria. Evidence-based recommendations were formulated using a narrative synthesis of the literature by subject experts. Recommendations for future research were also proposed.

Results In KQ1, a total of 1361 articles were reviewed, with 2 articles meeting inclusion. In KQ2, a total of 977 articles were reviewed, with 4 articles met inclusions criteria, of which 2 studies reported on the SARS-CoV2 virus specifically. Despite many publications in the field, very little well-controlled and unbiased data exist to inform the recommendations. Of that which is available, it shows that both laparoscopic and open operations in Covid-positive patients had similar rates of OR staff positivity rates; however, patients who underwent laparoscopic procedures had a lower perioperative mortality than open procedures. Also, SARS-CoV-2 particles have been detected in the surgical plume at laparoscopy.

Conclusion With demonstrated equivalence of operating room staff exposure, and noninferiority of laparoscopic access with respect to mortality, either laparoscopic or open approaches to abdominal operations may be used in patients with SARS-CoV-2. Measures should be employed for all laparoscopic or open cases to prevent exposure of operating room staff to the surgical plume, as virus can be present in this plume.

Keywords COVID-19 · Laparoscopy · Guidelines · Surgical plume · Safety

Abbreviations

OR Operating room
PCR Polymerase chain reaction
PPE Personal protective equipment

Executive summary

Background

The advent of the SARS-CoV-2 pandemic (COVID-19) has resulted in the disruption of life globally. The impact of this virus on the surgical patient, as well as those involved in perioperative care of the infected individual, has been poorly studied. Specifically, there are few publications available that provide recommendations for care of infected patients requiring surgery and safety measures for the surgical team. The aim of this work is to provide guidance based on current knowledge, and to initiate a living guidelines project which will adapt to advances in understanding of COVID-19. This will provide ongoing assistance to clinicians and

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institutions in their management of surgical patients during the pandemic.

Methods

Systematic reviews of the literature were conducted for 2 key questions regarding the safety of minimally invasive surgery in the setting of the COVID-19 pandemic. Evidence-based recommendations were formulated using a narrative synthesis of the literature by subject experts. Recommendations for future research were also proposed.

Interpretation of strong and conditional recommendations

All guideline recommendations were assigned either a "strong" or "conditional" recommendation. The words "the guideline panel recommends" are used for strong recommendations, and "the guideline panel suggests" for conditional recommendations.

How to use these guidelines

The aim of these guidelines is to assist surgeons, anesthesiologists, perioperative staff, patients, and physicians who make decisions about the management of patients requiring surgical intervention during the COVID-19 pandemic. These are also intended to provide education, inform advocacy, and describe future areas for research. The guidelines are meant to suggest the optimal, although not the only, approach for management given the intricacies of both the overall healthcare environment, as well as the nuances of individualized patient care. Specific situations may require adjustment of treatment plans to suit the needs and priorities of the individual patient. Finally, as these guidelines take a patient-centered approach. Patients can use these guidelines as a source of information and for discussion with their physicians.

Key questions addressed by these guidelines

1. Should minimally invasive surgery (laparoscopic or robotic) versus open abdominal surgery be used in COVID positive patients?
2. Should measures vs. no measures be taken to limit the surgical plume in order to mitigate viral particle exposure of operating room staff while performing minimally invasive surgery in the COVID-19 era?

Recommendations

1. *Should minimally invasive surgery versus open abdominal surgery be used in COVID positive patients?*

1a **With demonstrated equivalence of operating room staff exposure, and noninferiority of laparoscopic access with respect to mortality, either laparoscopic or open approaches to abdominal operations may be used in COVID-19 patients.**

1b **The decision of surgical approach should be based on the usual clinical factors, such as the risk of complications (including pulmonary), postoperative pain, return to full activity, and hospital length of stay. Where these factors favor laparoscopic surgery, the laparoscopic approach should be undertaken even in COVID-19 positive patients.**
(conditional recommendation, very low certainty of evidence).

2. *Should measures vs. no measures be taken to limit the surgical plume in order to mitigate viral particle exposure of operating room staff while performing minimally invasive surgery in the COVID-19 era?*

2a **With the detection of SARS-CoV-2 virus and other viruses in the laparoscopic plume, it is recommended that methods should be employed for all laparoscopic cases to prevent exposure of the operating room staff to the surgical plume, such as laparoscopic filters.**
(conditional recommendation, very low certainty of evidence).

Aim of these guidelines and specific objectives

The purpose of these guidelines is to provide evidence-based recommendations from a surgeon and patient perspective regarding the use of minimally invasive surgery (MIS) during the COVID-19 era. We assessed outcomes of laparoscopic versus open surgery in COVID-positive patients. We also assessed the threats to, and any related adverse outcomes, in the operating room staff to investigate whether measures should be taken to limit the surgical plume and viral particle exposure during MIS. Surgical plume was defined as the byproduct produced by energy devices (including electrosurgical instruments) created by the thermal damage of tissue. Personal protective equipment (PPE) use with COVID-positive patients may vary from region to region and thus was outside the scope of this guideline.

The key target audience includes patients, surgeons, perioperative staff, and anesthesiologists in a surgical setting. In addition, policy makers and insurance providers involved with health care services for the treatment of surgical patients during the COVID-19 pandemic may also take

these guidelines into consideration in their discussions and planning. Given the guidelines adopted a patient–surgeon relationship perspective, considerations such as resource requirements and health equity implications were not evaluated. A secondary aim is to form the basis of a living guidelines project which will adapt to yet emerging COVID-19 evidence, providing ongoing recommendations to surgical staff and hospitals.

Description of the health problems

The COVID-19 pandemic has completely disrupted global life since early 2020. Early recognition of the clinical symptoms of what is now known as the SARS-CoV-2 virus identified concerns regarding the risks of person-to-person transmission [1], including in healthcare settings [2, 3]. Despite the implementation of extensive public health measures, the disease continues to cause significant illness and death. Vaccination programs and treatment protocols continue to advance, but disease-related hospital admissions remain high. COVID-19 poses significant risk to both patients and hospital staff [4–7]. There are very few evidence-based guidelines currently published by surgical societies that provide recommendations regarding the surgical management of the COVID-19 patients.

The statements included in this guideline are the product of a systematic review of the published literature on the topic, with recommendations explicitly linked to the supporting evidence. The strengths and weaknesses of the available evidence are highlighted, with expert opinion supplementing where evidence was lacking.

How to use these guidelines

The aim of these guidelines is to assist all surgeons, anesthesiologists, perioperative staff, patients, and physicians who make decisions about management for their patients requiring surgical intervention during the COVID-19 pandemic. They are also intended to provide education, inform advocacy, and describe future areas for research. The guidelines are meant to suggest the optimal, although not the only, approach for patient management given the intricacies of both the overall healthcare environment as well as individual patient needs, including as related to co-morbidities.

Specific situations may require an adjustment of treatment plans to adapt to the needs and priorities of the individual patient. Finally, since the guidelines take a patient-centered approach, patients can use these guidelines as a source of information and for discussion with their physicians.

Methods

This guideline initiative was approved by the SAGES' guidelines committee and Chair (A.P.). A systematic review of the evidence informed the guideline recommendations (Fig. 1). Guideline panel members were subject matter experts with evidence review experience who performed the systematic review and formulated recommendations. The systematic review is reported briefly here, according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist. The guideline panel developed evidence-informed recommendations and graded the strength of recommendations via consensus. Reporting of the guideline adheres to the *Essential Reporting Items for Practice Guidelines in Healthcare* (RIGHT) checklist [8].

Guideline panel organization

Panel member expertise represented the knowledge domains of surgery, critical care, infectious disease, nursing, and epidemiology. The SAGES Guidelines Committee Fellow (A.C.) and guideline leads (R.J. and G.K.) facilitated guideline panel meetings, of which the fellow was a non-voting member of the panel. The guideline panelists formulated key questions and corresponding PICOs (patient—intervention—comparator—outcome) in consultation with the methodologist (M.A.) and Committee Chair (A.P.). After an introductory online conference reviewing the process and expectations, the panel convened during Spring 2021 for a series of online video meetings. The working group was responsible for the systematic review of the literature and faculty members participated as voting members of the expert panel. The expert panel was a multidisciplinary group of individuals was backgrounds in a diverse range of specialties involved with caring for COVID-positive patients.

Guideline funding & declaration and management of competing interests

SAGES provided funding for the librarian who assisted with the systematic review, for the methodologist, and for half the salary of the Guidelines Committee Fellow. No grants or other support came from industry, nor any input into the conception or development of this guideline. A SAGES' standard conflict of interest form was collected from all guideline contributors by the guideline lead (R.J.). A full list of declarations is listed at the end of the manuscript.

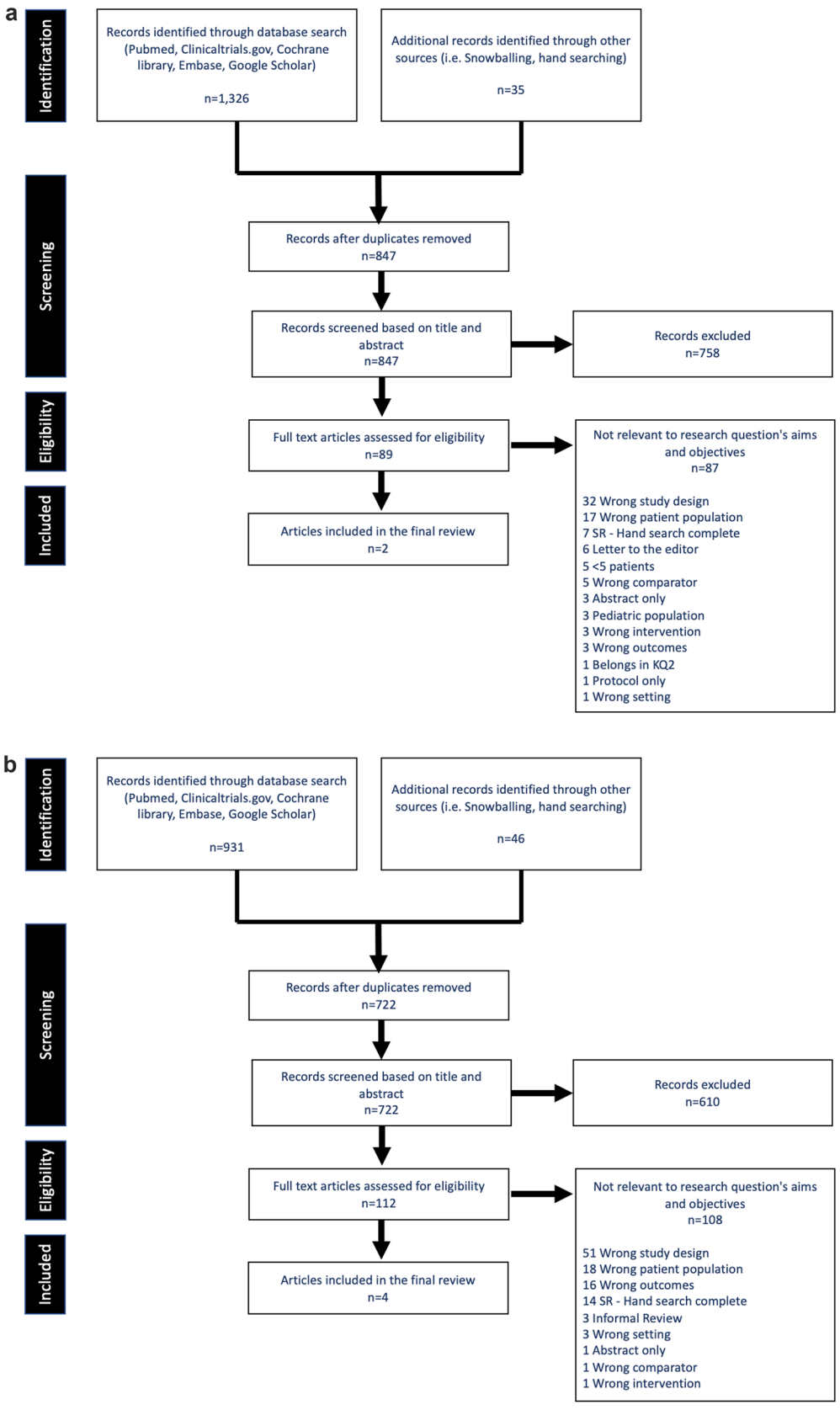

Fig. 1 **a** PRISMA for KQ1; **b** PRISMA for KQ2

Table 1 Screening eligibility criteria

	Inclusion criteria	Exclusion criteria
KQ 1–PICO P–COVID-positive surgical patients I-laparoscopy/robotic abdominal surgery C–open abdominal surgery O–OR staff exposure, Mortality, Hospital LOS, Vent LOS	Included study types (Systematic Reviews, Randomized control trials, Cohort study, Case–control, case series > 5 patients) Publication years 1990 to 2021	Thoracic procedures Vascular procedures Non-human studies Abstract only Non-English articles Single arm studies (< 5 patients)
KQ 2–PICO P–OR staff I–measures to limit surgical plume C–no measures O–OR staff exposure, viral particles detected in plume	Included study types (Systematic Reviews, Randomized control trials, Cohort study, Case–control, case series, case reports) Publication years 1990 to 2021	Thoracic procedures Vascular procedures Non-human studies Abstract only Non-English articles

Selection of questions and outcomes of interest

The use of MIS during the COVID-19 pandemic is the focus of this guideline. In view of the resource availability and timeliness of the guidelines, two guideline questions were finally prioritized with consensus. The questions covered are as follows:

(1) The equipoise related to the balance of patient benefit and harms of minimally invasive versus open surgery in COVID-19 settings, and.
(2) The equipoise related to the safety of the operating room staff.

Given their longstanding experience with patients, panel members voted for outcomes that they considered most patient–surgeon dyads would consider important or critical for decision-making. The final set of question specific outcomes were selected by simple majority. For the purposes of literature search strategy development and clarity in the reporting of this guideline, a COVID-positive patient was one that had either active COVID infection and/or testing positive on PCR testing for the virus.

Evidence review

A librarian searched multiple databases including PubMed, Cochrane Library, Clinicaltrials.gov, Google Scholar, and Embase, in February 2021 (the complete literature search strategy is available upon request). Systematic reviews were hand searched for additional studies missed in the literature search. An updated literature search was performed in May 2021 and this additional literature was assessed in the same fashion.

Standard systematic review approach using two independent reviewers (± third party arbitration) was adopted to screen and synthesize the best available evidence for each KQ. Retrieved records were reviewed, duplicates removed, and results screened for eligibility at two levels (title & abstract, and full-text review) against the eligibility criteria (Table 1). Only peer-reviewed English language studies were included during study selection, which comprised the bulk of the existing literature. Given the potential paucity of data, both randomized controlled trials (RCTs) and observational studies addressing the KQs of interest were eligible for inclusion.

The panel reviewed and synthesized the evidence consistent with the previously published SAGES Guidelines Committee Guidelines Committee Standard Operating Procedures [9]. Given the design of included studies, risk of bias was assessed using the modified Newcastle–Ottawa Scale (NOS) in the domains of selection, comparability, outcomes, and overall bias. Evidence was synthesized narratively. The results of the systematic review were incorporated into a spreadsheet for presentation to the panelists for appraisal and decision-making. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework was used, however, due to the limited comparative evidence, we were unable to create Evidence Tables nor Evidence to Decision tables.

Development of recommendations

The guideline panel considered the evidence in making judgments across various domains including the magnitude of the desirable and undesirable effects and the overall certainty of the evidence.

Utilizing a modified Delphi method, panel members underwent an iterative voting process to develop evidence-based recommendations. Working group leads (R.J. and G.K.) developed preliminary recommendations, which were then sent to the entire working group electronically for approval and feedback. Subsequently, the working group members convened for a virtual conference to

Table 2 Summary of evidence for KQ1

Included articles	Method of COVID testing in patients	Intervention	Hospital LOS, median (range)	Mortality (%)	OR staff exposure–staff tested positive (%)
Hadjittofi 2021	Reverse transcription polymerase chain reaction (RT-PCR)	Open	9.9 (2–57)	22.2	22.2%
		Laparoscopy	4.5 (0–45)	0	18.2%
Rasslan 2021	RT-PCR	Open only	30 (1–104)	31.8	Not Reported

discuss the results of the first round of survey and modify the text of the recommendations as required into provisional recommendations.

The available, albeit limited, evidence from the systemic review was presented to the full guideline panel in addition to the provisional working group recommendations. Feedback based on their specific area of expertise was solicited from the panel to inform judgments about the certainty of evidence and the balance of desirable and undesirable effects. These judgments further refined the provisional recommendations into a final text which was approved by members voting with at least 80% agreement.

Recommendations were intended to be evidence-based. The strength of evidence-based recommendations could be strong when high certainty evidence existed and desirable effects clearly outweighed harms, or conditional when lower certainty evidence existed, or the balance of effects was judged to be influenced by variable patient preferences. When evidence was lacking or inconclusive, recommendations were then to be based on expert opinion and consensus.

Values and preferences

Because expert opinion suggested absence of literature investigating patient values and preferences related to this topic, values and preferences literature was not specifically searched. Practicing panel members represented patient values and preferences to inform these guidelines.

Guideline document review

This guideline document was reviewed and edited by all working group members. In accordance with SAGES Guidelines Committee policies, the revised draft was distributed to the committee for comments. After incorporating these edits, the final guideline was then submitted to the SAGES Executive Committee and Board for approval and published online (www.sages.org) for public comment for additional quality assurance. Public comments were reviewed by the panel and considered in the development of our recommendations.

Recommendations

Key question 1

Should laparoscopic/robotic vs. open abdominal surgery be used in COVID-positive patients?

Recommendation

We suggest that in COVID-19 positive adult patients, who require abdominal surgery, either laparoscopic or open approaches be used, and the decision of surgical approach should be based on the usual clinical factors such as risk of complications (including pulmonary), postoperative pain, return to full activity, and hospital length of stay. Where these factors favor laparoscopic surgery, then the laparoscopic approach should be undertaken for Covid-19 patients.

(Conditional recommendation, very low certainty of evidence).

Summary of the evidence

Only two observational studies, one retrospective cohort study and one case series, met inclusion criteria with both deemed by the reviewers to be of high risk of bias [10, 11]. The two studies included 40 patients who underwent open abdominal surgeries and 55 who had laparoscopic surgery. Patient outcomes of perioperative mortality, ventilated days, and hospital length of stay were similar for both laparoscopic and open approaches to general surgical operations in patients who tested positive for COVID-19. Risk of operating room staff's Covid status changing from negative to positive in the postoperative period was similar between laparoscopic (18%) and open (22%) (Table 2).

Harms and burdens

When compared to open operations, laparoscopic procedures have been shown to result in fewer postoperative respiratory complications, faster return to full activity, less pain, and better cosmesis. However, longer operating time, laparoscopic smoke generation, and the physiologic effects of pneumoperitoneum may pose risks in the care of these

Table 3 Summary of evidence for KQ2

Included articles	Measures taken to limit surgical plume	Included procedures	Viral particles detected in plume
Romero-Velez 2020	Not explicitly described, but measures were taken to limit plume exposure	Laparoscopic appendectomy	None
Bogani 2021	A filter was applied to the trocar valve	Laparoscopic gynecologic oncologic procedures	Yes, 2 patients who screen negative for COVID preoperatively had viral particles in the surgical plume

patients. In the absence of data supporting one approach over the other, the recommendation of the panel is for the surgeon, in conjunction with the patient, to share informed decision-making in determining the surgical approach for a particular situation.

Decision criteria

Many factors are involved in the choice of operative approach to a gastrointestinal operation. Physiologic factors such as cardiorespiratory status and comorbidities, anatomic factors such as likelihood of intra-abdominal adhesions or altered anatomy, surgical factors such as the presumed pathology, and surgeon factors including training and experience, will all affect the decision. However, from the limited data available, the Covid status of the patient does not seem to have a large effect on outcome and therefore should not be a factor in the decision-making.

Thresholds for surgery during this pandemic are often recommended to be higher than during normal practice [12]. This is due to the increased risk of morbidity in patients with active COVID infection or those in early recovery from the disease. Many surgical societies have published recommendations cautioning against the use of laparoscopy in Covid-positive patients. [12–14] Nonetheless, the panel was unaware of other societal guidelines supporting the use a laparoscopy in gastrointestinal surgery as part of a shared decision-making strategy between surgeon and patient.

Research needs

At the time of writing, more than 207 million cases of Covid-19 have been reported globally, and more than 36 million in the USA alone. The fact that more rigorous studies have not yet been conducted speaks to the rapidity of onset of the pandemic and its overwhelming effect on healthcare systems. Now that clinicians are becoming more experienced in the management of the disease, with increasing community vaccination rates, resources will hopefully be devoted to addressing the question of the best surgical approach. Randomized controlled trials are achievable but will be difficult. Propensity score matched cohort studies should be large enough to deliver meaningful results. These studies are urgently required and should be deliverable in a short time frame.

Key question 2

Should measures vs. no measures be taken to limit the surgical plume in order to mitigate viral particle exposure of operating room staff while performing MIS *in the COVID-19 era*?

Recommendation

The panel recommends that measures, such as viral filters, should be employed for all minimally invasive cases to prevent exposure of operating room staff to the surgical plume.

(Conditional recommendation, very low certainty of evidence).

There has been a long-term perception among operating room staff that surgical smoke presents a serious health hazard [15], with guidelines recommending precautions against smoke inhalation by the entire surgical team [16]. Early in the COVID-19 pandemic, some protocols recommending open access over laparoscopic access for gastrointestinal procedures in Covid-positive patients were instituted, with a goal of decreasing the exposure of operating room staff to the surgical plume and therefore theoretically minimize associated infection risk [12].

Summary of the evidence

Four observational studies met criteria for inclusion, of which only two investigated the presence of SARS-CoV-2 in the surgical plume [17, 18]; the others examined for human papillomavirus and hepatitis B virus [19, 20]. The two Covid-19-related studies included a total of 18 patients who underwent laparoscopic gastrointestinal operations and both studies were judged to be at high risk of bias. Romero-Velez et al. was a case report that did not detect SARS-CoV-2 in the surgical plume taken directly from the trocar [18]. Bogani et al. was a case series that did detect the presence of SARS-CoV-2 in the surgical plume after using a filtered trocar [17]. No infection of operating room staff was documented as a result of exposure to the plume (Table 3).

Harms and burdens

The panel noted that SARS-CoV-2 particles have been detected in the surgical plume, but agreed that the infectivity of these particles, that is the ability of these particles to cause infection in those exposed to the plume, has not been demonstrated.

Decision criteria and additional considerations

Many factors may influence the infectivity of viral particles found in the surgical plume, including the temperature at which the smoke was formed by the electrosurgical device, the structure and stability of the virus, and the dose to which operating room staff members might be exposed. Data related to these factors was not available in the manuscripts included in our review. However, panelists were aware of some data examining infectivity, particularly from a single paper which had been excluded due to it being a non-human ex vivo non-peer reviewed study, which suggested that SARS-CoV-2 viral loads are very low in surgical plume [21]. However, based on the precautionary principle that SARS-CoV-2 particles have been detected in the surgical plume, without strong evidence of the inability of these particles to cause infection, the panel has recommended protection against exposure using laparoscopic viral filters.

The Royal Australasian College of Surgeons commissioned a guideline, published in 2020, and which was based on the work of an expert working group [22]. SARS-CoV-2 was found to be present in respiratory samples as well as feces and blood and, at the time of this manuscript, new data is emerging reporting viral particles in peritoneal fluid [23]. Despite this limitation and acknowledging the lack of evidence of actual transmission of disease to operating room staff, protective measures against smoke exposure were recommended. These recommendations should be taken into consideration with current national and international guidelines for the use of PPE during the COVID-19 pandemic.

It was also noted by the panel that implementation of protective measures against exposure will have a significant effect on cost of procedures (particularly given the volume of laparoscopic procedures performed by even the smallest of general surgical hospitals), the environmental waste generated, and the legal implication of intraoperative release of the smoke by inadvertently bypassing filters and other protective devices.

Research needs

It has been demonstrated that SARS-CoV-2 virus particles can be detected in the surgical plume. The presence of *any* viral particles informs this recommendation. Urgent research is required to demonstrate the infectivity risk of these particles, possibly using cell culture-based methods. The findings of such research may alter the recommendation of this panel.

Discussion

The systematic review demonstrated a marked paucity of data in this field. Much of what is available in the literature to date, including many societal position papers, were grounded simply on expert opinion based on first principles. Nevertheless, SAGES has taken an important first step in performing a systematic review of the literature and has provided evidence-based recommendations based on this review, using a multidisciplinary expert panel consensus. There was unanimous agreement that the surgeon should choose the best approach for the patient infected with SARS-CoV-2; this approach may be either open or minimally invasive.

The decision for which surgical approach to use is dependent on many factors, including patient factors (example, prior surgeries), disease-specific factors (example large diverticular phlegmon difficult to mobilize laparoscopically), and surgeon factors (example, little experience with a robotic approach to an incarcerated paraesophageal hernia). The recommendation presented here simply advises that the surgeon and his or her team make the best decision for the patient at that time. This decision should not be biased against a minimally invasive approach purely based on COVID positivity status of the patient or safety concerns for the operating room personnel. This is the first set of recommendations that has provided guidance based on a systematic review of the data.

The second recommendation is that the surgeon use viral filters during the case and controlled desufflation to minimize staff exposure to the surgical plume at the conclusion of the minimally invasive portion of a case. Active desufflation would include such measures as using an active evacuation system with suction that allows for gas to be vented into a closed circuit rather than into the room. This is based on the limited data demonstrating that viral particles can be present in the plume. In fact, there is data, albeit minimal, that infection can occur in the operating room from the surgical plume in the era of SARS-CoV-2. Aerosolization of particles is in fact not isolated to MIS and can also occur with open procedures as well. The expert panel felt, in an abundance of caution, that desufflation techniques should aim to minimize exposure of operating room staff to the surgical plume and the use of viral filters would be judicious in the era of this new virus with much that is still unknown. This recommendation has financial ramifications as desufflation equipment costs more than a passive "open the trocar" method of expelling gas from the abdomen. During expert

panel discussion, input from the senior operating room nurse suggested that this is not an insurmountable issue and that including active suction tubing to the insufflation circuit can be achieved relatively easily in high income countries. In low to middle income countries this may be more difficult or even cost prohibitive. At minimum, PPE with respiratory protection, such as a properly fitted N-95 mask and eye protection, for all staff involved should be provided and is of utmost importance. There are also ramifications for education, as it may be habitual for many surgeons to just open the stopcock to the trocar to desufflate. This may require some surgeons to change their daily practices, which will require habituation, but these guidelines provide impetus regarding this change. Even when protective mechanisms are employed, it is common for a small amount of pneumoperitoneum to escape when inserting laparoscopic instruments into the ports. Research to evaluate optimal methods of minimizing this gas escape will be important.

As the evidence surrounding the safety of MIS in the era of the COVID-19 pandemic evolves, so must our published guideline recommendations. SAGES Guidelines Committee has a Living Guidelines Task Force, which checks for new and pertinent evidence at regular intervals [9]. Due to the quickly emerging field surrounding COVID-19, the Living Guidelines Task force will be charged with frequent literature search updates and will report any germane data. There will be a formal review of the literature and any changes to our recommendations, based on newly published data, will be communicated to the public. It is possible that more nuanced recommendations, specific to surgery type, might be made based on this greater body of evidence. Especially in light of newly emerging variants (i.e., Delta and Omicron), this process of updating the recommendations as new data is published is critical. The behavior of future and currently understudied variants is unknown at this time and this expert panel has made recommendations on the best available evidence at the time of the writing of this manuscript.

Limitations

There are several limitations to these recommendations. First, all the literature identified had an inherently very low certainty of evidence. As such, our data had insufficient evidence to undergo formal grading by GRADE methodology. Our recommendations are based on limited published evidence. We made every effort to include a broad, diverse set of expert panel members, however, bias is an inherent risk present in expert opinion. In addition, although we took a patient-centered perspective, we did not include patient advocates in our panels and their values were represented by proxy of the experts. There continues to be new evidence regarding the surgical implications of the SARS-CoV2 virus. For example, recent studies have shown the presence of the virus in tissues, on the floor, and on instruments [21, 23]. However, these additional sources of potential viral spread were beyond the scope of this guideline. We propose multiple research priorities, in an effort to improve the certainty and quality of the evidence for the important clinical questions surrounding the COVID-19 pandemic impact on surgery.

Conclusion

This systematic review identified a paucity of data that met the inclusion and exclusion parameters. However, the available data and expert option suggests that it is safe to use either minimally invasive or open techniques (at surgeons' discretion) to treat the surgical patient who is infected with SARS-CoV-2. Laparoscopic filters should be used to limit surgical plume in order to reduce viral exposure of OR staff. Active desufflation should be encouraged at the end of a laparoscopic case that requires insufflation.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00464-022-09133-w.

Declarations

Disclosures Amelia T. Collings, Nader Hanna, Jonathan Dort, Pramod Nepal, Chelsea Lin, Julie S. Hong, Geoffrey P. Kohn have no conflicts of interest or financial ties to disclosures. D. Rohan Jeyarajah is a consultant for Sirtex, Angiodynamics, Ethicon. Shawn Tsuda is a speaker for Intuitive Surgical, Allergan, Covidien. Robert Lim receives honoraria from Up to Date, Inc., Lunch from Boston Scientific and Medtronic. Mohammed T. Ansari receives consultant fees from SAGES. Bethany J. Slater is a consultant for Bolder Surgical. Aurora Pryor is a speaker and advisor for Ethicon, Medtronic, Gore and Stryker.

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