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Directives of general surgical practice during the COVID-19 pandemic: A systematic review

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Abstract:

The coronavirus disease 2019 (COVID-19) is a serious global pandemic that has extremely affected health-care systems. This article aimed to review the perspectives of general surgical practice during the COVID-19 pandemic. A systematic review of the literature addressing modification to general surgical practice during the COVID-19 pandemic indexed in PubMed, Scopus, Google, and Google scholar was carried out on June 19–20, 2020. The literature review yielded 577 articles. The exclusion of duplication, articles not in English, and specialized ones in various surgical disciplines precluded 398 articles. Finally, following checking for relevance and publication status, 114 papers were included. Recommendations for surgical practice during the COVID-19 pandemic revolved around mitigation of the risk of virus transmission to patients and health-care workers. The emerging themes of safety precautions were related to patient prioritization and testing, mindful consideration of the operative strategy, optimum use of personal protective equipment, operative room setup, and departmental organization. However, those recommendations were often diverging and bore on a dearth of evidence and personal opinions. Multidisciplinary work and cooperation among surgical specialties are required to establish and validate the protocols for safe surgical practice during the pandemic and perhaps similar crises in future. The COVID-19 pandemic has brought several challenges to the field of medicine, including the surgical specialty. The centrality of safety precautions emerging in this crisis requires surgeons to adopt the new roles and work standards and translate them into practice during the pandemic and perhaps longer.

Keywords:

Coronavirus disease 2019, departmental organization, general surgical practice, operative room guidelines, patient prioritization, patient testing, personal protective equipment

Introduction

The first case of the acute severe respiratory syndrome, the novel coronavirus disease 2019 (COVID-19), was reported in Wuhan City, China, in December 2019. Dramatically, the disease has spread to many countries and was declared by the WHO as pandemic on March 11, 2020.^[1] Inflicting more than 25 million and killing hundreds of thousands of people in a couple of months, it was one of the disasters rarely seen in the history of humanity.^[2] The thrilling pandemic has imposed an unprecedented challenge to

health-care systems' integrity in the many parts of the world and tested to the extreme limits their capacity to survive amid unusual crises.^[3] Hospital resources were diverted to cope with the overwhelming number of COVID-19 patients at other disease costs. Besides, health-care workers (HCWs) found themselves at the forefront of the battle line fighting an obscure enemy, sometimes barehanded, that hundreds of them lost their lives.^[4,5]

Surgery was significantly impacted by the cancellation of elective procedures, exploitation of operating rooms (ORs) as additional premises, and redeployment

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of surgeons to help in the care of COVID-19 critically ill patients.^[4,6] Besides, the staff was redistributed to preserve the workforce, while others were either isolated, quarantined, or succumbed to the disease.^[7-9] Consequently, surgical departments suffered understaffed in risky situations where surgeons had to cope with new work circumstances and guidelines to which they were not acquainted.^[4] Added to this is the interruption of the ongoing surgical training and education, let alone the psychological burden imposed on staff due to movement restriction, loss of leisure time, and the fear of contracting the COVID-19 infection.^[10] General surgery was probably the most affected among other surgical specialties, given the extensive and broad range of procedures carried out by general surgeons in hospitals and ambulatory settings.^[11]

Amid these perplexing conditions, attempts were made to modify the existing practice to limit the spread of the infection among HCWs and patients and concomitantly preserve the standards of surgical care.^[7] This article aims to review the modifications incurred to general surgical practice during the pandemic tailored to address the risks of HCWs and optimize the use of the available resources.

Materials and Methods

A systematic review of the published articles regarding general surgical practice during the COVID-19 pandemic, indexed in PubMed, Scopus, Google, and Google Scholar, was conducted between June 19 and 20, 2020 following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.^[12] The search was done using the terms [Surgical practice] AND [Covid-19] or [COVID-19] limited to the document's title. The inclusion criteria comprised articles tackling modifications to practice in general surgery, for example, departmental structure, patient prioritization and testing, choice of the surgical procedure, and operative room guidelines in addition to the publication status and language. The exclusion criteria included articles in other subspecialties, for example, orthopedics, otorhinolaryngology, and urology involving detailed disease management and those addressing general hospital financial and administrative issues. Articles that were not in English or not yet published were also excluded.

The literature search yielded 577 articles. Initial screening of abstracts resulted in excluding 398 articles that were not related to general surgical practice, duplicated or not in English. In the second round, 179 articles were reviewed for relevance and 65 were further excluded. Eventually, 114 articles were included in this review, including original and review articles, short reports, commentaries, and letters to editors. Figure 1 summarizes the flowchart of the literature review process.

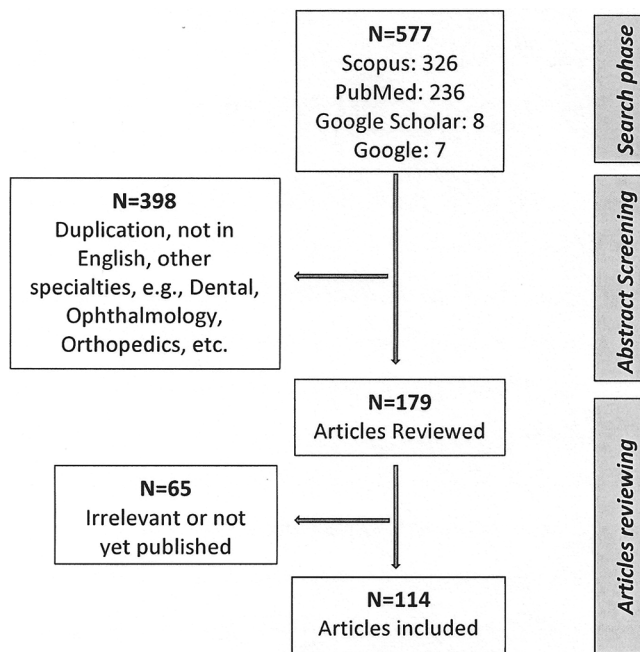


Figure 1: Summary of the systematic review process

Results

Perspectives of general surgical practice during the COVID-19 pandemic revolved around ensuring safety and decreasing the risk of infection to patients and HCWs. The main emerging themes of safety precautions were related to patient prioritization and testing, judicious selection of the operative approach, optimum use of personal protective equipment (PPE), operative room setup, and departmental organization. Modification to the routine surgical work to minimize the risk of virus transmission during the pandemic is discussed below under the above-mentioned aspects of surgical practice.

Patients' prioritization

Reduction of the surgical volume was proposed widely to reduce the risk of viral transmission and streamline the available resources toward COVID-19 patients.^[6,11] Besides, COVID-19 patients are subjected to increased risk of postoperative morbidity and mortality, which necessitates balancing the benefit of surgery against the risk of infection.^[13,14] Therefore, a strategy to prioritize patients for surgical care was recommended, where procedures were categorized based on their time sensitivity into essential (risk of untoward outcomes if delayed) and nonessential or discretionary, which can be deferred safely.^[7,15-17] Detailed scales for patient prioritization were described, including the American College of Surgeons' Elective Surgery Acuity Scale.^[18,19] However, contextual factors should be considered, including the spread of the coronavirus, the influx of COVID-19 patients, bed occupancy, and the availability of staff and resources.^[20]

It was argued that “elective” does not mean “optional,” and many elective procedures often require urgent intervention sometime in future.^[9] In urgent surgeries, consideration of the comorbidities, the American Association of Anesthesiologist Class, and the hemodynamic stability might imply the length of hospital stay and the demand for intensive care postoperatively and hence promote decisions of candidacy for such operations.^[6,21] As such, priority for surgery should be decided carefully, preferably through panels of expertise, particularly in cancer cases where the procedure’s postponement may impose risks of disease progression and decreased quality of life.^[22,23] However, transparency is essential, and the development of protocols to standardize patients’ prioritization on equitable and ethically based grounds is recommended.^[24]

Patients’ testing

Screening for COVID-19 is essential in the perioperative period to ensure the safety of patients and HCWs, particularly that up to 80% of patients may be asymptomatic.^[5,15,25] Moreover, it has implications for surgery outcomes and the rational use of PPE.^[26] However, variable recommendations for testing were noticed in different geographical locations driven by limited tests availability.^[27,28] A spectrum of testing practices was observed extending from no testing in areas with low prevalence to screening only symptomatic patients ending with testing all patients scheduled for surgery.^[1,26,29,30] Controversy existed regarding the results of the few published articles regarding the efficacy of such testing protocols. Some articles reported no cross-infection despite restricted testing regimens,^[26,29,31] while others have shown the contrary.^[5,27,28] Arguably, pending on the safety side might necessitate testing all patients scheduled for surgery, given the compelling issue of asymptomatic and presymptomatic patients; However, the practicality and cost-effectiveness of such an approach are yet to be validated.^[28-30]

At least, all high-risk patients (with upper respiratory tract symptoms, fever, or history of contact or travel to high prevalence area) should be tested for COVID-19 upon admission in addition to those who later develop symptoms.^[5,32] In COVID-19 confirmed cases, surgery should be delayed, if possible until the patient is asymptomatic for at least 72 h, and he/she tested negative twice and 24 h apart.^[22,33] Retesting is also recommended upon discharging patients.^[34] All patients should be dealt with as COVID-19 positive in life-saving procedures until test results are available and all protective measures taken accordingly.^[35,36]

Real-time polymerase chain reaction test (RT-PCR) is the gold standard and has a sensitivity of 78%.^[6,21,37] It should be done 48–72 h before or the closest to surgery.^[5,37]

Nasopharyngeal swabbing might not be as yielding as bronchoalveolar lavage, yet it is safer.^[37] RT-PCR results may take a relatively long time ranging between 4 and 120 h, and the possibility of false-negative results should be borne in mind, particularly in the late course of the disease.^[5,18,30]

The majority of COVID-19 patients show abnormal findings on lung computed tomography (CT) scans, which is particularly useful in patients undergoing emergency surgery where time does not suffice for an RT-PCR test.^[20] A chest X-ray might also be done adjunct to the lung CT in the emergency operations.^[20] The sensitivity of the lung CT is reported in one study to be as high as 98%;^[5] however, the combination of lung CT and PCR is claimed to provide the highest sensitivity, and their negative predictive value is approaching 100%.^[21,32] Serology for coronavirus antibodies (IgG, IgM) is a rapid test; however, it may indicate a past rather than a current infection episode and may be negative in the early days postinfection.^[5,30] Other blood tests, including lymphopenia, neutrophilia, and increased C-reactive proteins, D-dimers, lactate dehydrogenase, creatine kinase, serum ferritin, and alanine transaminase, were reported. It might significantly determine the severity of COVID-19 or negatively predict its possibility if otherwise normal.^[5,38]

Use of personal protective equipment

As mentioned earlier, the prevention of virus transmission and ensuring HCWs and patients’ safety are of utmost priority. The virus is well known to spread through respiratory droplets, and its transmission through airborne and orofecal routes is inconclusive.^[6,19] Therefore, the full protection of HCWs is essential, particularly in procedures that involve aerosol generation taking laparoscopy, endoscopy, and procedures on the airway as examples.^[39] PPE encompasses surgical masks, N95, face filtering piece (FFP2 and FFP3), and powered air-purifying respirators to guard against airborne transmission, and waterproof gowns, gloves, face shields, goggles, overall, head, and shoe covers, and boots to protect against spillage of secretions.^[21,23,36,37] However, the availability and constant PPE supply were compromising, and protocols were set forth to optimize their use, particularly in resource-limited settings.^[4,8] For instance, three protection levels were suggested; primary and secondary ones when conducting routine ward work with low risk and confirmed or suspected cases, respectively, and a tertiary level when performing high-risk procedures that involve aerosolization as mentioned above.^[33] Training HCWs on the procedures of donning and doffing to minimize the risk of virus transmission are crucial, especially the latter, which carries a higher risk.^[18,20,40] Besides, surgical facemask should be applied to all patients who are not intubated.^[15]

PPE is also required during waste disposal, sanitation of operative rooms, and other hospital premises.^[31,40]

Unfortunately, some articles pointed to poor PPE applications by HCWs due to either unavailability or that their appropriate use is not strictly followed.^[7] Geographical variation in the rate of COVID-19 infection among HCWs was observed and attributed to compliance with the appropriate use of PPEs.^[41]

Choice of the procedure

The increased postoperative morbidity and mortality associated with COVID-19 have embarked reconsideration of surgical care standards, including the operative strategy.^[13,20,42] High mortality and intensive care unit (ICU) admission rates were reported in association with aggressive and lengthy surgical procedures in COVID-19 patients, given its adverse effect on the immune system.^[26,43,44] Besides, lengthy procedures increase surgeons' exposure time, and consequently, their susceptibility to the infection, given that isolation in the OR is impossible.^[14] Therefore, a wise operative approach to mitigate the risk of infection revolves around decreasing the operative time and the length of hospital stay.^[44-46] This entails commending the least possible operative intervention and considering surgical therapy alternatives if they are equally effective.^[5,11,13,23] However, local factors, including the status of the virus spread, bed occupancy, and availability of ICUs and PPE, should also be considered.^[44,47]

As such, acute appendicitis could be treated conservatively with antibiotics accepting the risk of relatively higher recurrence rate. In addition, Cholecystostomy and interval rather than early cholecystectomy may be planned for acute cholecystitis to delay surgical intervention and avoid a more aggressive approach.^[6,14] Similarly, loop colostomy as a staged procedure for colonic obstruction is preferred to a more radical approach of colectomy and primary anastomosis, and stenting might be safer than palliative resection.^[6,27] Besides, taxis and neoadjuvant therapy can be useful strategies to defer surgery in incarcerated hernia and oncologic operations, respectively.^[23,33] Intuitively, the standard procedure to which the surgeon is acquainted should be done by the most expert to decrease the exposure time and the need for undue re-intervention.^[45,48]

Controversy existed regarding the choice of minimal access versus open procedures during the pandemic.^[7,8,25,33] Although the former has numerous advantages, including minimum physical impact on the body and shorter hospital stay, an increased risk of virus transmission through aerosol generation in surgical plume and pneumoperitoneum was alluded.^[4,15,20,22] Such risk is contemplated based on the

assertion of aerosolization of human papilloma virus, Hepatitis B, and human immunodeficiency viruses in surgical smoke and pneumoperitoneum in previous observations.^[49,50] Laparoscopy might be avoided in COVID-19 patients or where surgeons are not well trained on it; open surgery might be safer in such circumstances. However, smoke evacuation is still necessary.^[27,49,50] Nevertheless, laparoscopic interventions should be decided prudently on individual bases and underwent when the benefits outweigh the risks, and the necessary precautions to decrease the likelihood of infection were enacted.^[6,7,41,51,52] These include applying the minimum pneumoperitoneum pressure, creating appropriately sized trocar incisions, and using bipolar electrocautery. Besides, setting laser and ultrasonic dissection devices at the minimum energy and using filters for pneumoperitoneum deflation and smoke evacuation at the nearest generation.^[33,45,53,54]

The selected operative intervention should not compromise the standards of care but be modified to decrease the risk of infection.^[13,42] However, it was argued that an operative approach with inferior results might still be ethically acceptable if the risk of COVID-19 and its associated morbidity and mortality can be significantly lowered.^[42] In consonance, although autonomy is an undisputed patient's right, it can be overridden by society's benefit, given the high pressure of the pandemic on the health-care systems.^[55] The increased morbidity and mortality, considering the risk of surgery and COVID-19, should be discussed clearly with the patient and be subsumed in the consent form to avoid medicolegal dilemmas.^[3,42,47]

Departmental organization

Outpatient clinics

Strategies to decrease exposure are essentially required to retain HCWs in the workforce during the pandemic.^[56] As such, the number of outpatient clinics should be reduced, and telemedicine used instead to initially assess patients and evaluate their need to come to the hospital.^[35] Videoconferences, email, phone calls, and social media applications were attempted to facilitate perioperative assessment and follow-up.^[4,23,57] Virtual clinics allow for sorting out patients and interpreting the results of their investigations and may, therefore, speed up treatment and spot those who need to attend in person for further assessment.^[7,52] Photos of diseased body parts could also be supplemented online to provide a visual clue to the diagnosis.^[58] However, triage by general practitioners and surgeons is occasionally mandatory.^[59]

Where the patient has to attend for further evaluation, a time-specific appointment should be booked in advance, prioritizing patients based on their health circumstances, for instance, cancer patients owing to their increased

risk of infection.^[14,21] A detailed history of suggestive COVID-19 symptoms should be sought and temperature checked to triage patients outside.^[33] The number of HCWs should be kept to the minimum considering presence of the most senior staff to minimize the need for re-consultation.^[8,37,56] As such, and where possible, residents, medical officers, interns, and other junior staff should be exempted.^[56,60] Patients should apply facemasks and employ social distancing, and measures should be taken to prevent them from moving across each other.^[21,33] Surgeons should bypass most but the essential parts of the physical examination and ensure PPE's appropriate use.^[33] Besides, rooms must be well ventilated, and surfaces disinfected in intervals between patients.

Staff

Many surgeons were lost from the workforce due to redeployment or COVID-19 contact or infection.^[7] Besides, many of them were subjected to mental stress, the so-called "the *hidden or parallel pandemic*" due to unfamiliar work and life circumstances, and the fear of contracting the infection.^[9,10,22,56,57] As such, strategies were proposed to retain HCWs in the workforce to maintain service and meet any surge in the number of COVID-19 cases.^[23,56] Such recommendations included designating hospitals for COVID-19 patients and restructuring staff into small groups to work on a shift basis (e.g., every two weeks coinciding with the virus's incubation period).^[8,56,60] Unnecessary HCWs and nonmedical staff should stay at home^[5,8] but be encouraged to stay connected to maintain teamwork and minimize the psychological burden as well.^[23,60]

HCWs should work in only one hospital, and teams might be assigned to COVID and non-COVID-19 patients. Furthermore, those who serve COVID-19 patients may work for extended shifts to optimize resources.^[8,40] Similarly, surgical departments might be set as "standard sections" for COVID free patients and "observational areas" for suspected cases.^[8,33] However, the legitimacy of such segregation measures is criticized given the questionable ability of HCWs to withstand long shifts with COVID-19 patients and the efficacy with which virus transmission could be prevented.^[6] HCWs should maintain a duty of self-evaluation and testing should they developed symptoms of COVID-19 and self-isolation if they harbored the infection.^[36,52] Training HCWs on prevention strategies, including reducing paperwork and documentation, are essential to alleviate fear and anxiety and reduce infection risk.^[8,33]

Operative room guidelines

Operating room building

A designate OR complex for COVID-19 patients is recommended.^[6,15,23,35,56] If in the same building, the

OR for COVID-19 patients should be next to the main entrance and is zone-colored.^[8,29,40,50] Special areas for donning and doffing should be provided.^[51] Doors and windows should be kept closed during surgery, and telecommunication devices used to decrease traffic.^[15,20,52] The OR suite should be equipped with negative pressure and air renewal systems and, if not available, the use of filters is advocated (e.g., high efficiency and ultralow particulate filters).^[36,54] Positive pressure systems should be stopped during surgery and turned on at least 20 min after the patient has left the OR.^[51] Turnover time should be increased to allow for proper sterilization and disinfection as emphasis is mainly on safety rather than productivity.^[10,23,52]

Patients

COVID-19 patients should have wrist tags and be operated on at the end of the list if there is no separate OR complex.^[36] Patients should be transferred to the OR with dedicated porters through the shortest route that is clear and labeled, avoiding traffic and right away to the OR.^[20,33,37,40] Designated routes and elevators should be used and adequately disinfected.^[20,35] Examination, induction, intubation, extubation, and recovery procedures are preferably conducted in the OR to reduce the contamination of other areas.^[6,20] Specimens should be carefully labeled as originating from COVID or non-COVID-19 patients.^[36]

Operating room staff

The number of attendants should be kept to the minimum, and a detailed list of all participants is needed for contact tracing.^[6,15,40] Surgeons and their assisting staff should enter the OR only after intubation and leave before extubating the patient.^[19,37,49,52] Intraoperative documentation should be discouraged, and all paper-based records are kept outside the OR.^[20,40] First and second "timeouts," checklists, designated roles, and adequate preoperative planning and communication are advocated to avoid mistakes and ensure safety.^[6,37,41,52] A runner should be available outside the OR to help bring anything required from the outside.^[15,20] A dedicated OR team was recommended to minimize cross-infection risk with other staff members.^[20,27,37] Considering the modern ventilation systems that pump air from the ceiling and absorb it near the floor, it might be safer for staff to remain in the room center and avoid leaning or sitting on the ground.^[49] Staff should shower and change uniforms before resuming their routine work.^[6]

Instruments

Single-use instruments were recommended; otherwise, proper sterilization and disinfection are indicated.^[4,33,36] Essential items should be brought to the OR in advance, and once the operation started, attempts should be made to use the instruments already available.^[6,15,37]

Unnecessary devices should be kept outside the OR or otherwise left inside, wrapped with plastic shields.^[6,20,35] Well-identifiable containers should be preserved for hazardous waste disposal, while Linen should be immediately sealed and appropriately cleaned and sterilized.^[40]

Discussion

Recommendations for surgical practice during the COVID-19 pandemic revolved around mitigation of the risk of virus transmission to patients and HCWs. Therefore, deferment of elective surgeries, appropriate use of PPE, and mindful consideration of the operative strategy were prospected. Besides, modification to the routines of departmental work and operative room guidelines were inevitable. However, those recommendations were often diverging and bore on a dearth of evidence and personal opinions. Multidisciplinary work and cooperation are required to establish and validate protocols for safe surgical practice during the pandemic and perhaps similar crises in the future.

Concomitantly, resumption of surgical service is expected to face some challenges that would require careful anticipation and management.^[23,52] The large number of cases queued due to elective surgery's cancellation created a backlog that would necessitate extra efforts and time to clear up.^[1,24,57] Therefore, the patient prioritization strategy adopted during the pandemic may supervene for a while and may prolong the time-lapse for surgery, which is already lengthy.^[39,61] Disease progression, particularly in cancer surgery, may alter the presentation and impose additional diagnostic and therapeutic challenges in the postpandemic period.^[62] The adverse effects of loss of work on the psychological well-being and hand-skills of surgeons were speculated and require vigilance given the uncertainty of when the pandemic will end over.^[22,46,57] It has been highlighted that flattening the curve does not decrease the absolute number of cases; instead, it spreads them over a more extended period so that health-care systems could sustain it.^[63] Figure 2 summarizes the current perspectives of surgical practice to combat the Covid-19 disease and may require further study and modification.

Limitations and recommendation

There is a dearth of evidence to support most of the recommendations mentioned earlier, which mainly hinges on personal opinions and limited evidence trials and may inevitably change in due time. Besides, a follow-up search of the literature was not done, which may render part of the information written in this article outdated. However, such a labile medium is expected, given our limited knowledge regarding the novel coronavirus,

- 1. Patients' prioritization**
 - Postpone elective surgical procedures.
 - Defer surgery in COVID-19 patients, if possible.
 - Consider the time-sensitivity of the procedure and the expected harm to the patient.
 - Use scales where applicable, e.g., ASA and elective surgery acuity scale, and consider comorbidities.
 - Establish protocols to ensure transparency and equitable care.
- 2. Patients' screening**
 - Screen all or at least high-risk patients for COVID-19.
 - RT-PCR is the gold standard test.
 - Lung CT and chest X-ray are useful in the emergency setting.
 - PCR, combined with lung CT has the highest sensitivity and negative predictive values.
 - PCR test the closest to surgery.
 - Serology is a rapid test but may indicate past infection.
- 3. Use of PPE**
 - Full protection of HCWs to limit virus transmission.
 - Optimize use according to the risk imposed by surgery.
 - Training staff on donning and doffing.
- 4. Choice of the procedure**
 - Priority for the shortest and least aggressive interventions.
 - Consider non-surgical treatment when equally effective.
 - The standard surgical approach by the most expert.
 - Avoid laparoscopy in COVID-19 patients; minimize aerosol generation and use smoke and pneumoperitoneum filters.
- 5. Departmental organization**
 - Reduce outpatient clinics and use telemedicine.
 - Restructure staff to work on a shift basis.
 - Designated COVID-19 free and observation areas.
 - Conduct only the essential physical examination.
- 6. Operative room recommendations**
 - Designated COVID-19 and non-COVID-19 complexes.
 - Unique routes and uninterrupted transfer of patients.
 - Ampule team communication and planning.
 - Dedicated COVID-19 staff.
 - The least number of attendants.
 - Reduce inside and outside traffic.
 - All necessary instruments inside.
 - Use negative pressure.
 - Careful labeling of specimens.
 - Increase transit time to maximize safety.

Figure 2: Summary of the recommendations

which is still evolving. The articulation of protocols through multidisciplinary and collaborative approaches to resume surgical practice safely is an anticipated initiative.^[24,34] Fortunately, surgeons showed good will and worked assiduously to maintain service and help other departments sustain their work during the pandemic's challenging times, which was quite reassuring.^[1,55]

Conclusion

The COVID-19 pandemic has imposed an unprecedented challenge to the integrity of health-care systems in many parts of the world and tested to the extreme limits their capacity to survive amid unusual crises. Surgery was not an exception and suffered due to the diversion of resources to care for the escalating numbers of COVID-19 patients. Such pressures implied modification of the current practice to limit virus transmission yet maintaining the standards of surgical care and training. Multidisciplinary initiatives and cooperation are required to establish evidence-based protocols for safe practice and resumption of surgical service. As the whole world is learning from this tragic experience, surgeons might need to adopt new roles and work standards and translate these into their practice during the COVID-19 pandemic and perhaps longer.

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Conflicts of interest

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