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Operational Directives for Surgical Practice During COVID-19 Era: An Analytical Approach-Based on Systematic Review of Published Recommendations

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Abstract

Many surgical guidelines for COVID-19 rely on expert opinion leading to heterogeneity. We aim to systematically analyze published surgical recommendations in COVID-19 pandemic. Searches on PubMed and EMBASE of published surgical recommendations were conducted. Articles with recommendations on research questions covering at least two or more of five key domains were included. Eighty-six articles met inclusion criteria and were analysed. 43 (50.0%) articles recommended restricted outpatient clinics and tele-clinics. 35 (40.7%) guidelines recommended to delay elective onco-surgery in current pandemic. 17 (19.8%) recommended chemotherapy/radiotherapy if delay is inevitable. Majority recommended tiered framework for surgery (severity basis) (81.4%) and preoperative testing COVID-19 59 (68.6%). Limiting professional in operating rooms (72.1%), full protection even in surgery of low risk patient (60.5%), operating rooms with negative pressure ventilation (67.4%) were major recommendations. Precautions during laparoscopy surgery and use of smoke filters were recommended. Transitional facility with isolation for post-emergency surgery till COVID-19 test proved negative was highlighted by 26 articles and 11 highlighted careful assessment of postoperative fever and respiratory complications. Although there were heterogeneity majority recommendations were triage of surgical case, screening for COVID-19, adequate protection of healthcare professional, negative pressure ventilation in operating rooms and use of tele-clinics.

Keywords: chemotherapy/radiotherapy, COVID-19; operational directives; surgical practice.

Introduction

COVID-19 disease had its origin in Wuhan, China and has evolved into a global pandemic (1). As of June 25, 2020, there have been 9,532,038 cases reported with 485,122 fatalities worldwide (2). The health-related social and economic fallout of the pandemic is immeasurable. Restructuring of healthcare structure with creation of dedicated COVID wards, ICUs and hospitals has been necessary in an effort to control the pandemic.

Surgical specialties are no exception to the effect of COVID-19. It is estimated that as many as 2.8 million surgeries have been cancelled or postponed in the peak span of 12 weeks of COVID-19 pandemic (3, 4). When resuming surgeries, appropriate preparation and precautions need to be taken to ensure safety to healthcare workers (HCWs) and patients.

A number of guidelines and recommendations for safe conduct of surgery and management of surgical patients have been published. Unfortunately, many of these recommendations rely heavily on expert or individual opinion, as the evidence base is lacking. This leads to considerable heterogeneity and confusion which highlights the need for a common global guidance for surgical care in COVID-19 pandemic. The aim of the current review was to systematically analyze recommendations published by various surgical societies and health institutions, which addresses key domains pertaining to surgical practice in times of COVID-19.

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Methodology

A systematic search was performed in the PubMed and EMBASE database (January 2019 - 5th June 2020) using the standard keywords. A complete detailed search can be found in supplementary table 1. The results obtained from two databases were combined and duplicates removed. The initial screening was performed on the basis of title and abstract by four investigators (KBD, RS, AK, MC). No restriction of language, ethnicity or type of paper was made. The screening performed in duplicate and the conflicts between the investigators were resolved after discussion with the fifth reviewer. The articles relating to surgery and surgical practice or service in the pandemic of COVID-19 were taken for full-text screening. The systematic review is reported in accordance with PRISMA guidelines (5). This study is registered in PROSPERO (Registration no: CRD42020202155) and permission granted from institutional review board.

Selection of studies

Two investigators (RS, MC) separately assessed full text articles for eligibility with conflicts resolved with third investigator (KBD). All articles dealing with guidelines related to principles of surgery in COVID-19 pandemic and addressing at least two or more of the five key domains were included for final analysis. Articles published in non-English language were included if translation were available. The article not meeting inclusion criteria, small commentary, brief communication and editorial giving vague information on guidelines, clinical studies, systematic and scooping reviews, meta-analysis, preclinical and public studies were excluded.

Data items and data collection process

The research questions covering important aspects of five key domains were framed as mentioned in table 1 to 5. The five key domains identified for inclusion were: Guidelines for conducting outpatient clinics and surgical aspects of cancer care; Preoperative management and admission; Guidelines for surgical team; Guidelines for the operating room and technical aspects of surgery; and Postoperative considerations and follow-up of patients.

The included articles were pooled to a common theme identified and finally charted. The theme of the answers was given more importance than the language expression used. New recommendations were considered if the theme was completely different than previously included one. The conflicts regarding the recommendations and common theme were resolved after discussion among the investigators. The frequency along with percentages of various recommendations were calculated. The levels of evidence were determined as described by the Oxford Centre for Evidence-Based Medicine (6). The statistical analysis was conducted using R version 4.0.1 (7).

Results

Search Results

Total of 8707 records were identified for initial screening after removing duplicate records. Out of these, 475 articles were selected for full text screening. Finally, 86 articles met the inclusion criteria and were selected for detailed evaluation and analysis. The details are shown in Figure 1 in the PRISMA flow chart. Among included articles 32 articles were guidelines from various surgical societies. All of the studies were of level 5 evidence as they were based upon expert opinion. Formal bias assessment was not done as most of the articles were expert opinion. The details of included articles like first author, country of origin, societies and references are provided in supplementary table 2. The results of key five domains of research question are listed below:

Outpatient Clinics and Surgical Aspects of Cancer Care

Majority of articles (50.0%) recommended the policy of outpatient service with a restricted number of patients, especially the needier ones. Policy to use tele-clinics as an integral part of the system to triage patients and reduce unnecessary visits was advocated by half of the articles (50.%). The majority promoted use of protection in form of N95/FFP 2 filter masks. To manage the challenge of elective cancer surgery, 40.7% have recommended delaying surgery after careful assessment of risk of progression on a case by case basis. Noteworthy, 26

(30.2%) of the articles recommended considering chemotherapy/radiotherapy if the hospital policy demands to postpone surgery especially in overburdened resources and service due to this pandemic. Details of recommendations are shown in Table 1.

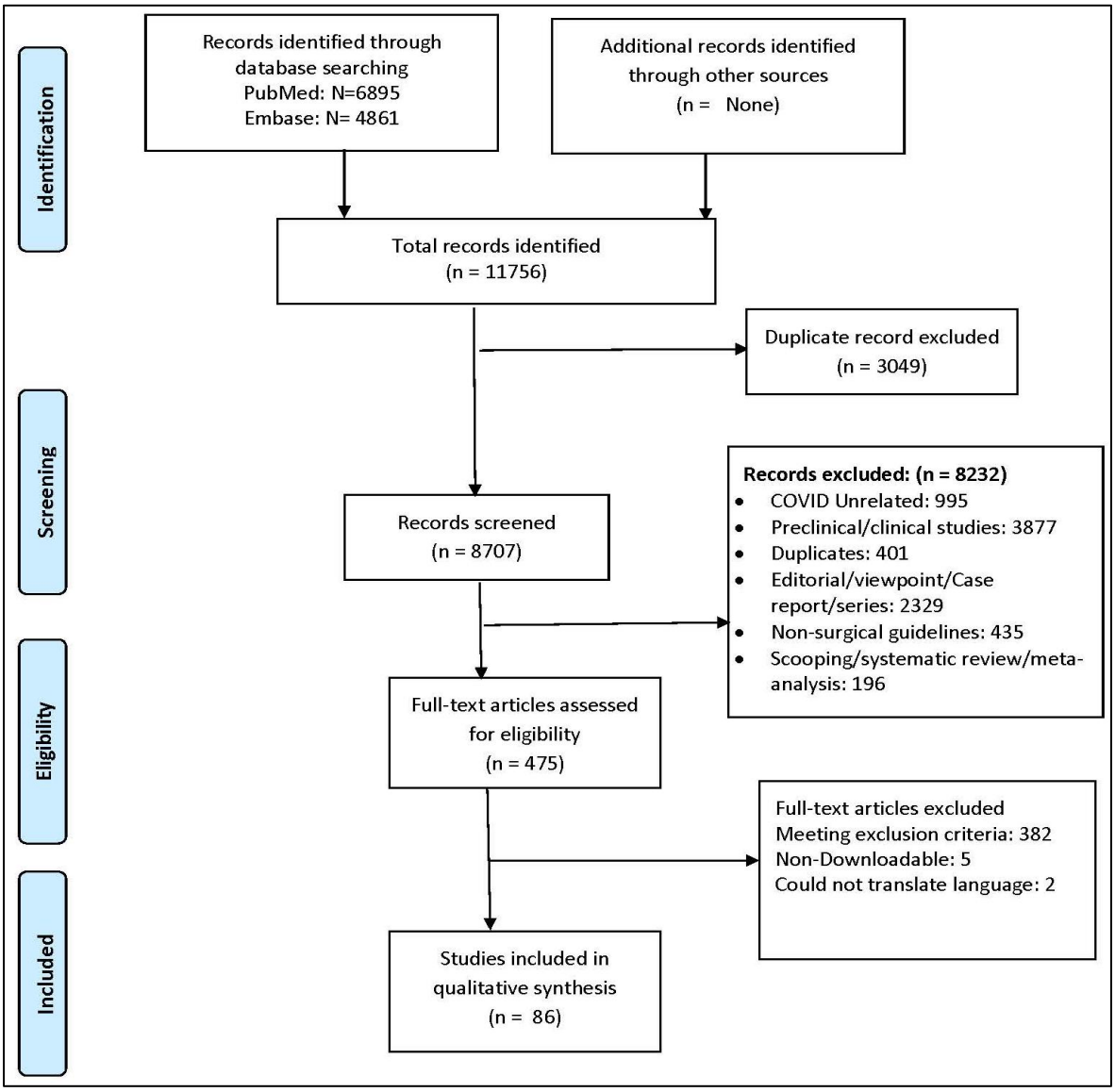

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Diagram for the literature search results

Preoperative Patient Management and Admission Criteria

The need to triage patients on the basis of disease severity forming tiered framework for admission and surgery was highlighted in 81.4% of studies. Routine screening for COVID-19 prior to surgery was a majority (68.6%) consensus among the studies. When considering conservative management of common surgical emergencies (e.g. appendicitis, complicated gallstone disease, etc.), careful assessment on a case to case basis considering risk of morbidity and prolonged hospital stay was highlighted in 22.1% of articles. The Guidelines regarding safe blood transfusion practice in this pandemic was mentioned in only nine articles. The details are mentioned in Table 2.

Table 1: Details of recommendations covering outpatient clinics and surgical aspects of cancer care

S No.	Research questions	Recommendations	n(%)N=86
1	Should the outpatient clinics be regular or restricted?	Restricted	43 (50.0%)
		Regular	2 (2.3%)
		Not mentioned	41 (47.7%)
2	What are the recommendations regarding Tele-clinics?	Should be integral part of management	43 (50.0%)
		Can be optional	1 (1.2%)
		Not mentioned	42 (48.8%)
3	Should all healthcare professionals wear FFP2 filter mask/N95 mask/protective equipment or a simple surgical mask is enough?	Yes at all times	33 (38.4%)
		Only in high risk scenarios	12 (13.9%)
		Surgical masks are equally effective	4 (4.6%)
		Not mentioned	37(43.0%)
4	Should all patients wear masks?	Yes	21 (24.4%)
		Only for symptomatic individuals	8 (9.3%)
		Only patients with high-risk of COVID-19 infections	3 (3.5%)
		Not mentioned	54(62.8%)
5	Should we postpone elective Onco-surgery?	Consider postponing elective surgery for cancer patients with low risk of progression on case-by-case basis	35 (40.7%)
		Don't delay for long /Delay only if COVID-19+ve	4 (4.6%)
		Yes, postpone the elective onco-surgery	3 (3.5%)
		Not Mentioned	44 (51.2%)
6	Should we change the management protocol to Chemotherapy ± Radiotherapy first?	Change only if chemotherapy/radiotherapy has been shown to be of equivalent efficacy or proven to have role in neoadjuvant setting	17 (19.8%)
		Yes, the change is required in management protocol	9 (10.4%)
		Not mentioned	60 (69.8%)

Guidelines for Surgical Team Management

Limiting the number of surgical teams (led by senior surgeons), ensuring adequate preparedness prior to surgery to reduce movement in and out of the Operating room (OR) were highlighted in 72.1% of included studies. While the majority (75.6%) recommended standard full personal protective equipment (PPE) during surgery for COVID-19 infected patients, the need for protection was highlighted by majority (60.5%) even in the surgery of low risk or COVID-19 negative patients. Additional use of powered air purifying respirators (PAPRs) especially in high-risk aerosol generating procedures was recommended by 17.4% of the studies. High risk healthcare workers (HCW) like pregnant mothers, old age with comorbidities and on immunosuppressant, need special careful consideration during selection by the surgical team. Only six articles recommended considering the risk associated with these special HCW while making a surgical team. The detailed findings are depicted in Table 3.

Operative Room and Technical Aspects of Surgery

Majority (67.4%) of the guidelines recommended use of isolated OR with negative pressure ventilation for surgery in COVID-19 infected patients.

Table 2: Details of recommendations covering preoperative patient management and admission

S No	Research questions	Recommendations	n(%) N=86
1	Should we triage patients routinely on the basis of disease severity or urgency for surgical planning?	Yes, limiting all "non- essential" surgeries and procedures until further notice, providing a tiered framework	70 (81.4%)
		Not mentioned	16 (18.6%)
2	Should we do routine screening for COVID-19 by definitive tests for all patients planned for elective surgery ?	Better to test for all cases	59 (68.6%)
		Compulsory for high risk of suspicion	10 (11.6%)
		Not mentioned	17 (19.8%)
3	Should we treat all emergency surgery patients as COVID +ve?	Yes	50 (58.1%)
		Triage in COVID low risk and high risk group	15 (17.4%)
		Not mentioned	21 (24.4%)
4	Should patient consent sheets routinely include risk of getting COVID-19 infection?	Yes	16 (18.6%)
		Not mentioned	70 (81.4%)
5	What are guidelines regarding blood transfusion and blood products management in surgical patients?	Consider adequacy of blood products.	7 (8.1%)
		Consider screening for COVID-19 prior in blood products prior to blood transfusion	2 (2.3%)
		Not mentioned	77 (89.5%)
6	Should conservative management be preferred over surgical management for common surgical emergencies like appendicitis, cholecystitis, abscess, obstructed hernia etc?	Yes, if possible	19 (22.1%)
		Not mentioned	67 (77.9%)

In addition to negative pressure ventilation, high frequency air exchange was advocated by 18 articles and another 14 articles recommended integrated high efficiency particulate Air (HEPA) filters in negative pressure OR ventilation. Use of HEPA filters, ultra-low particulate air (ULPA) filters for smoke evacuation systems and OR ventilation was mentioned in 35 (40.7%) studies. Other recommendations along with specific use of filters are shown in table 4. Seven guidelines were against laparoscopy service during this pandemic while 17 guidelines recommended careful consideration of laparoscopic surgeries after risk evaluation with necessary precautions. Eleven articles were in favor of laparoscopic surgery as there was minimal evidence of relative risk. The need for development of proper hospital protocol for separate operative waste management was highlighted in 41.9% of included articles. Details of recommendations are shown in Table 4.

Guidelines For Postoperative Management and Follow-Up

The need for transitional facilities with isolation beds for postoperative patients after emergency surgery was highlighted in 20.9% articles for all cases and 9.3% of them recommended only for high-risk patients. Use of tele clinics was recommended by 40.7% of included guidelines for postoperative follow-up to limit the hospital visit.

Table 3: Details of recommendations covering surgical team management

S No	Research questions	Recommendations	n(%) N=86
1	What are the recommended manpower in the operating team?	Limit the number of professionals and their movements.	62 (72.1%)
		Surgical team should be divided in two separate broad team: 1) For high risk or COVID-19+ve patients 2) For low risk and COVID-19 -ve patients	2 (2.3%)
		Bigger team additional nursing staff, security team, runner to minimise delays and effective communication	1 (1.2%)
		Not mentioned	21 (24.4%)
2	What are the minimum requirements of personal protection for the Operating Room(OR) team during surgery for low risk or COVID negative patients?	Full PPE recommended by standard guidelines	52 (60.5%)
		As required in conventional surgery with addition of protective glasses and FFP2 type/N95 mask, face shield	13 (15.1%)
		Protection used for conventional surgery consisting of Surgical masks	8 (9.3%)
		Not mentioned	13 (15.1%)
3	What are the minimum requirements of personal protection for OR teams during surgery for High risk or COVID positive patients?	Full PPE as recommended in Standard Guidelines	65 (75.6%)
		Full PPE + additionally PAPR for aerosol generating procedure	15 (17.4%)
		Not mentioned	6 (6.9%)
4	Should Surgeons be grouped or team designed taking in consideration the high risk groups like pregnant doctors, older age surgeons or surgeons with comorbidities	Yes	6 (6.9%)
		Not mentioned	80 (93.0%)

Additional guidelines for discharge and patient education are shown in table 5. PRISMA checklist has been provided in supplementary Table 3.

Discussion

We have evaluated the recommended practices reported in different surgical guidelines around the world in an analytical approach. As the results are based on published reports by recognized societies or experts in the field in the majority of cases, the review generates robust summary regarding best known surgical practices. This study highlights the broad principles of surgical practice in COVID-19 era common to general surgery and many surgical specialties and is not focused on individual challenges faced by different specialties as this would be beyond the aim of our study, we recommend surgical specialty specific standard guidelines for them. But still, as guidelines were society or expert opinion, articles provided OCEBM (6) level 5 evidence generating grade D recommendations. Additionally, this study also showed heterogeneity among various recommendations. Restricted outpatient services operated with necessary precautions was advocated by the majority of the publications. Expansion of telemedicine as a feasible and acceptable complementary service to triage the patients was emphasized in most recommendations.

Table 4: Details of recommendations covering operative room and technical aspects of surgery

S no	Research questions	Recommendations	n (%) N=86
1	What are guidelines for OR ventilation?	Isolated OR with negative pressure ventilation	58 (67.4%)
		Any OT ventilation with at least fitted HEPA/ULPA filters	3 (3.5%)
		The operating room should remain positive pressure, but the surrounding rooms (i.e. ante-room(s)) must maintain a strict negative pressure ventilation system	1 (1.2%)
		Not mentioned	24 (27.9%)
2	What are recommendations regarding surgical smoke evacuation during open and laparoscopic surgeries?	Low pneumoperitoneum pressures, avoid port site gas leak/use balloon trocars, smoke extractors fitted with smoke filters	23 (26.7%)
		Minimize surgical smoke by liberal suctioning and keep electrosurgical equipment to lowest effective power, low CO_2 pressure/avoid laparoscopy	15 (17.4%)
		Closed smoke evacuation/filtration system with ULPA capability	6 (6.9%)
		Not mentioned	42 (48.8%)
3	What are recommendations for HEPA/ULPA filters in OR?	Should be attached with the ventilation system of OR	11 (12.8%)
		Should be part of smoke evacuation/filtration system	13 (15.1%)
		Should be part of filters attached with OR ventilation and smoke evacuation filters	11 (12.8%)
		Not mentioned	51 (59.3%)
4	Should we choose open surgery over Laparoscopy?	Make careful decision	17 (19.8%)
		Very little evidence regarding relative risks of laparoscopy to prefer open surgery over laparoscopy	11 (12.8%)
		Yes	7 (8.1%)
		Not mentioned	51 (59.3%)
5	What are arguments in favor of laparoscopy surgery?	Very little evidence regarding relative risks of laparoscopy	10 (11.6%)
		No evidence of relative risks of laparoscopy. Additionally smoke/aerosol generated in laparoscopy is contained within abdomen and can be easily removed via filters but in open surgery aerosol are uncontrolled	9 (10.5%)
		Not mentioned	67 (80.7%)
6	Separate operative waste management after surgery in COVID-19 infected individuals	Operative waste management should be strictly followed as per infection control protocol	36 (41.9%)
		Not mentioned	50 (58.1%)

OR: Operating room, HEPA: high efficiency particulate Air, ULPA: ultra-low particulate air, CO_2: Carbon dioxide

This is consistent with studies which shows significantly reduced unnecessary hospital visits, travel time and costs (8, 9). While dealing with patients in outpatient clinics, use of N95/ FFP2 masks has been recommended. Although N95 respirators have been shown to provide superior protection (10), medical institutions have to make protocol judiciously considering benefits in low-risk settings, cost as well as its availability.

Table 5: Details of recommendations covering postoperative management and follow up

S No	Research questions	Recommendations	n(%) n=86
1	Should all patients undergoing surgery be kept in a transitional/isolation ward before the result of the test for COVID-19?	Yes	18 (20.9%)
		Only suspected case in perioperative period should be kept in isolation ward	8 (9.3%)
		Not mentioned	60 (69.8%)
2	What are guidelines to approach postoperative fever and respiratory complications?	All postoperative new onset fever or respiratory complications like cough, pneumonia etc. should be isolated and investigated to rule out COVID	9 (10.5%)
		Other postoperative complications/progression of primary disease should also be carefully considered along with evaluation for COVID-19	3 (3.5%)
		Not mentioned	74 (86.0%)
3	What are guidelines for patient education during discharge?	Proper hygiene-behavioural rules to avoid subsequent superinfections, accurate and frequent hand washing, wearing a surgical mask and of social distancing	16 (19.3%)
		Maintain healthy lifestyle should be isolated in home for 14 days after being discharged from hospital	2 (2.3%)
		Not mentioned	68 (79.1%)
4	Should Telephonic/tele-clinics be used for follow up?	Yes	35 (40.7%)
		Not mentioned	51 (59.3%)

Prognosis of malignant disease is time dependent and surgical management demands large manpower and resources including intensive care unit (ICU) beds. This may compromise hospital preparedness to this pandemic. Balanced approach, as shown in our study, is to delay elective cancer surgery on a case-by-case basis by evaluating risk of progression. Consensus was present among articles for utilizing tiered framework for triaging patients. American College of Surgeons recommended elective surgery acuity scale (ESAS) to triage non emergent surgeries in COVID-19 pandemic (11). ESAS groups patients and disease in different tiers and determines the level of urgency for admission and surgery. The screening of patients for COVID-19 prior to surgery is widely recommended in our study. Asymptomatic COVID-19 infected individuals account for approximately 40% to 45% and are contagious (12). The policy of screening can also minimize postoperative morbidity and mortality especially in elective settings. In a multicentre study (13) evaluating surgical outcomes in 1128 COVID-19 infected patients, overall, 30-day mortality was 23.8% and pulmonary complications accounted for the majority (81.7%) of all deaths. Hence, the recovery from COVID-19 infection prior to surgery is recommended in non-emergent surgeries.

The reverse transcriptase polymerase chain reaction (RT-PCR) routinely used for diagnosing COVID-19 has sensitivity of around 70% and specificity of 95% with false negativity rates around 29% (14, 15). The sensitivity also varies based on the site and quality of sampling (16). The data describes the need to approach even low risk or COVID-19 negative

patients with precautions and the same was reflected in the present study. Although levels of protection of PPE were not well defined in many included articles, it was well recommended to use full PPE during surgery of COVID-19 infected patients. Additionally, 16.3% of papers recommended using powered air purifying respirators (PAPR) especially in high-risk aerosol generating procedures. PAPR offers higher protection factors as they can filter ≥ 99.97% of particles 0.3µm in diameter, are more comfortable, and do not require fit testing. However, routine use results in high cost and communication difficulties intraoperatively (17). Furthermore, the clinical evidence of being more effective in reducing risk of viral airborne transmission in clinical health care settings is limited (17).

One of the important aspects in surgical practice is safe blood transfusion. There was paucity of clear recommendations regarding blood transfusions in most articles. Only nine articles highlighted the importance of maintaining a continuity of blood and blood products in present situations. Though there are no reported transfusion related COVID-19 infections (18), RNA of COVID-19 has been detected in blood in 15% to 40% of infected individuals (16). Similarly screening of the donor is also important. Thalassaemia International Federation (19) recommends deferring blood donation for at least 28 days after symptoms resolution and completion of therapy in infected donors.

The planning of the OR team is a vital part of the preparedness of the surgical department. Surgical teams should remain outside the OR during the intubation/ extubation and should enter the operating team after some time to allow adequate air exchange (20). Our study showed majority consensus on the need of negative pressure air flow in OR to contain the aerosols generated in a variety of surgical procedures. Though there is no direct evidence of COVID-19 transmission through surgical smoke, previous studies have demonstrated different viruses like corynebacterium, human papillomavirus (HPV), poliovirus, human immunodeficiency virus and hepatitis B in surgical smoke (21). Kwak et al. had shown the presence of hepatitis B virus in 10 out of 11 samples of surgical smoke (22). Further measures to minimize exposure as elaborated in our study was use of high frequency air exchange (around 25 cycles/hour) which rapidly reduces viral load within OR (23). HEPA filters can filter 99.97% of particles larger than 0.3µm and are recommended to be integrated in OR ventilation and smoke evacuation systems (19, 23). ULPA filters have efficacy of retaining 99·9 % of particles at 0·1 µm (24). Currently, the most effective smoke evacuation system is the triple-filter system which includes a prefilter, a ULPA filter, and a special charcoal (24).

Laparoscopy in the era of COVID-19 has remained controversial. There is no evidence in support or against laparoscopy. However, the need for general anesthesia, generation of aerosol due to dissection and use of energy sources in the peritoneal cavity under pressure may lead to explosive dispersion of aerosol during instrument exchange, trocar and gas release (25). After initial inhibition, several guidelines have been published for safe laparoscopy (26, 27). Pneumoperitoneum and surgical smokes are contained within the abdominal cavity as opposed in open surgery and can be easily taken care if appropriate measures are taken. Benefits of laparoscopy surgery can be used by taking precautions to minimize gas leak from pneumoperitoneum. This includes minimizing skin incision for trocar, low pneumoperitoneum pressure, low electrocautery power settings, smoke evacuation filters like HEPA/ULPA filters etc. (26, 27). Our study showed a majority (28 articles) consensus for laparoscopy surgery after taking all necessary precautions. Interestingly, evaluation of peritoneal fluid and wash sample during laparoscopic appendectomy in a COVID-19 patient did not show the virus (28). There are only a few papers providing insight in postoperative management. The study highlighted the need for transitional facilities with isolation after emergency surgery till the test proves negative.

This study has numbers of limitations. The papers included are either expert opinion or society guidelines which provided low level of evidence and recommendation. As a common theme of guidelines was used for data entry, there can be subjective bias of investigators while interpreting the

recommendation during data entry. Furthermore, these guidelines are bound to change as experience increases. The strength of this study is that the research questions extensively address all key domains of general surgical care provided to patients. The number of publications reviewed was also modestly large and this study has successfully summarized the findings of the heterogeneously available guidelines and recommendations in a systematic way.

Conclusion

The common recommendations which emerged from most of the available guidelines have been analytically summarized. This study would be valuable in formulating surgical guidelines by societies, organizations, and hospital to handle infection prevention.

Abbreviation

None.

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None.

Author Contributions

KBD, RS, PKM, MC, SG: Literature search, reading and data collection; KBD, RS, AAK, MC: Responsible for data analysis and interpretation; KBD, RS, MC: Part of manuscript preparation process; KBD, RC, AAK, PKM, LA, NPN, AS, VW: Involved in manuscript editing and proof-reading; KBD, PKM, RS: Played their role in table preparation and image editing; KBD, RS, LA, NP: Part of final editing and finalising the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

Ethics Approval

Not applicable.

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