



# Strategies for Optimizing the Use of PPE During Surgery in COVID-19 Pandemic: Rapid Scoping Review of Guidelines

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## Abstract

Personal protective equipment (PPE) plays a fundamental role in the prevention of spread to Health Care Professionals (HCP) ; especially in a surgical setting. This scoping review of surgery guidelines was performed to appraise the quality of appropriate PPE recommendations and propose a strategy to optimize the PPE usage. This rapid scoping review of guidelines on surgery during COVID-19 was conducted according to Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews protocol. Important databases were searched from January 1, 2020 to July 31, 2020, for relevant studies produced by a national/international academic association/organization, in English literature, using relevant keywords. Quality of evidence was graded according to GRADE guidelines. The searches yielded a total of 1725 studies, out of these 41 guidelines on surgery during COVID-19 matching with pre-defined criteria were evaluated. The level of evidence was uniformly rated “low,” as assessed by GRADE guidelines and recommendations provided by them were mostly non-specific covering a narrow range of items. The crucial issue of optimization of PPE was not addressed at all. Economic implications demand optimization of PPE and conservation of resources. A simple decision-making algorithm addressing all the limitations of guidelines can be constructed, which allows HCPs to safeguard themselves and at the same time optimize/ conserving resources.

**Keywords** Personal protective equipment · COVID-19 pandemic · Surgery · Guidelines

## Introduction

As the COVID-19 pandemic rages across the world with no end or clear treatment in sight, its prevention is of paramount importance. Prevention of patient-to-patient transmission and prevention of patient-to-Health Care Professionals (HCPs) transmission is the main focus of this effort. Personal

protective equipment (PPE) plays a fundamental role in the prevention of spread to HCPs; especially in a surgical setting. However, the term “PPE,” a contemporary buzzword, is not standardized and broadly includes a variety of masks, respirators, gloves, gowns, or body covers. Furthermore, meeting its universal demand has been hindered by economic reasons, misinformation, panic buying, and stockpiling during a pandemic. Rationale use of PPEs is the need of the hour not only because of its cost but also since the majority of the countries have not witnessed the pandemic’s peak, yet some are facing the second wave, logistically forcing us to be ready for a long-drawn battle [1]. The medical world responded quickly to the current pandemic and came out with many rapidly emerging guidelines; however, most of these did not pass the stringent tests of the quality of evidence and methodology because the necessary clinical experience/evidence is still evolving [2, 3]. This prompted us to perform a scoping review of surgery guidelines that emerged during the COVID-19 pandemic to identify the appropriate PPE recommendations, appraise their quality, and propose a strategy to optimize the PPE usage.

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## Methods

This rapid scoping review of guidelines on surgery and laparoscopic surgery during COVID-19 was conducted according to the PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) protocol and did not need prior registration [4].

**Search Strategy** The following databases were searched from January 1, 2020, to July 31, 2020, for relevant studies: Medline, Embase, Global Health, Scopus, Web of Science Core Collection, WHO, Global Index Medicus, and Google Scholar. The search strategy included terms related to clinical practice guidelines and its synonyms (“clinical pathway,” “clinical protocol,” “consensus,” “consensus development conference,” “critical pathways,” “guidelines,” “practice guidelines,” “health planning guidelines,” “guideline,” “practice guideline,” “position statement,” “policy statement,” “practice parameter,” “best practice,” “standards,” “recommendations”) and coronavirus diseases and its synonyms (“SARS-cov 2,” “covid 19,” “coronavirus,” “novel coronavirus,” “coronavirus covid-19”) and personal protective equipment and its synonyms (“PPE,” “N95,” “Respirator”). Apart from scholarly/published material, hand-searching of key international surgical associations, minimal access surgery associations and laparoscopic and endoscopic surgery associations and a grey literature search was also performed.

The inclusion criterion was that the guidelines on surgery/laparoscopic surgery must have been produced by a national/international academic association/organization, in English literature. Exclusion criteria were guidelines exclusively concerned with anesthesia procedure; regional/hospital/government guidelines; non-peer-reviewed guidelines; commentaries, reviews, viewpoints, opinions, case series, case reports, or recommendations from individual author or group of authors or institutes.

Two reviewers (SKY and VA) reviewed the potential abstracts and if required, full texts of the search material to select the studies that appeared to be a “best fit” with stated objectives. Full articles of selected studies were reviewed in detail, and resolution of any disagreements was done in consultation with third and fourth authors (PA and DS).

**Data Synthesis** An all-inclusive list of relevant geographical, methodological, surgical, and evaluation of evidence parameters was made after a preliminary review of included guidelines. The various parameters included in the evaluation were the country of origin, level of evidence, and special attention to the recommendations on types/indications/donning method/disposal of PPE. The parameters were identified in every included guideline and were finally tabulated in a standardized Microsoft Excel Version 16 form. The result was

assessed for each of the criteria and evaluated as recommended/not recommended/not available. Quality of evidence was graded according to GRADE guidelines: as very low/ low/ moderate/high [5].

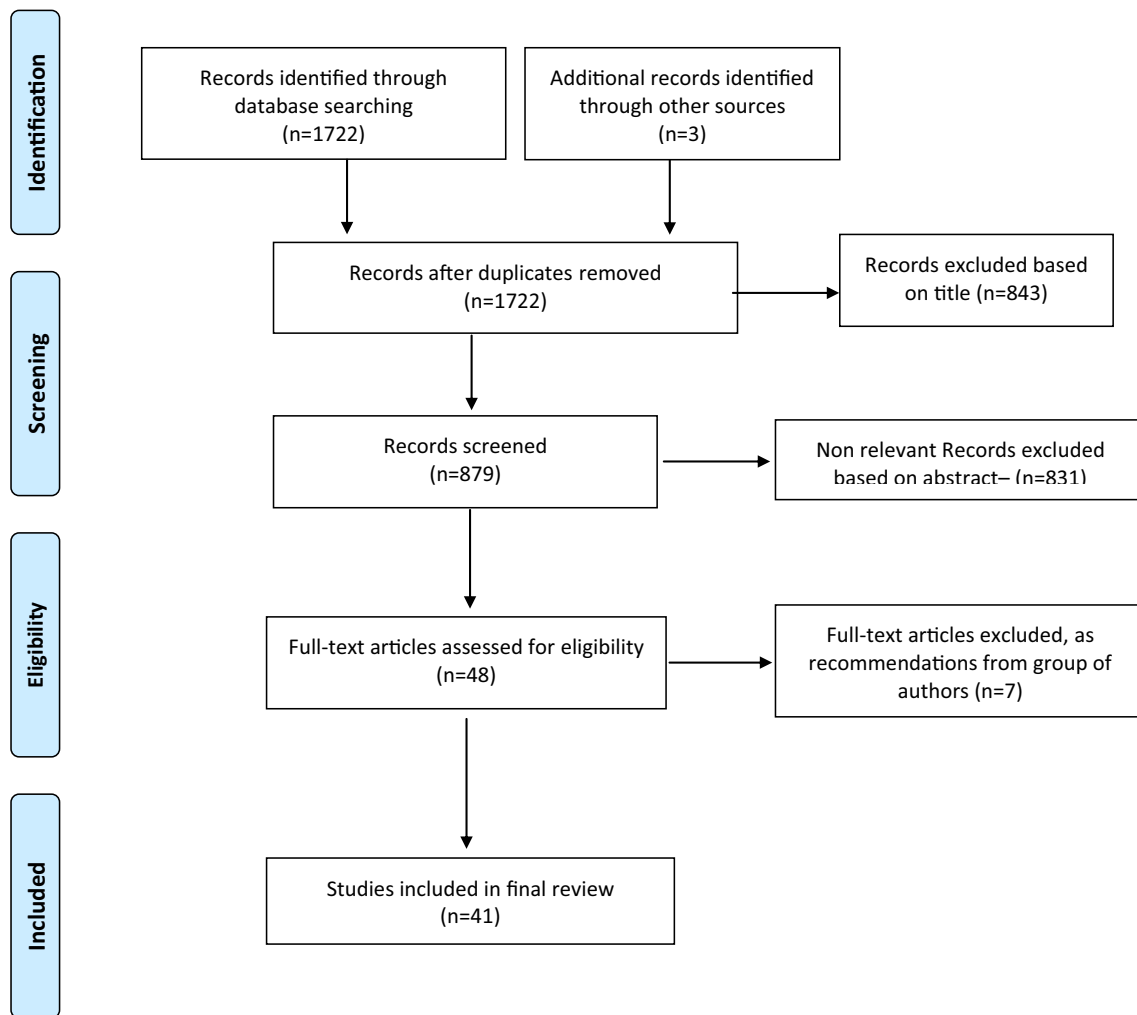
## Result

The initial search yielded a total of 1725 studies, out of these 41 guidelines on surgery and laparoscopic surgery during COVID-19 matching with pre-defined criteria were chosen and evaluated in this rapid scoping review (Fig. 1).

A summary of all guidelines with the origin of their country, academic association, type of study, type of evidence and recommendations based on various surgical/technical parameters are shown in Table 1 [6–46].

In general, guidelines on types/indications/method/disposal of PPE were embedded within a document that primarily focused on surgery/laparoscopic surgery, and recommendations provided by them were mostly non-specific covering a narrow range of items (Table 2).

A maximum number of guidelines originated from individual National associations (27/41), followed by regional societies (9/41) and international societies (5/41). Globally, only 8/41 guidelines were published by national associations from LMICs. None of the guidelines qualified to be evidence-based clinical practice guidelines in terms of the level of evidence and the methodology adopted for the development of guidelines. The level of evidence was uniformly rated “low,” as assessed by GRADE guidelines, as they were based on level 3 evidence and grade C recommendations (Table 1) [4]. The most commonly recommended PPE was in the form of gloves (unspecified, 90.24%), head cap (90.24%), N95 respirator (82.92%), front doffing gown (90.24%), and face shield (87.80%). Though the N95 respirator (filtering facepiece mask; FFP2 in one) was the most commonly recommended respirator, a surgical mask (2 or 3 layered) was recommended in 5/41 and powered air-purifying respirators (PAPR) in only 1/41 guidelines. Enhanced personal protective equipment (EPPE) suit was recommended in 92.68% of COVID-19 positive patients and 55.53% of COVID-19 negative patients. Use of EPPE in positive patients by all staff members in OR was recommended by 68.29% of guidelines, while 12.19% were not in favor of that. High-risk aerosol-generating procedures (HAGP) were poorly defined in most of the guidelines on minimally invasive surgery (17); however, the use of EPPE in HAGP was recommended in 9/17 guidelines irrespective of COVID-19 status, 7 did not recommend and 6 did not mention it. The donning and doffing technique of PPE was described in only 21.95% of studies. Disposal of PPE was either not described or was poorly described in almost all guidelines. Surprisingly, there was no guidance on decontamination and re-use of face shield/



**Fig. 1** Flow chart summarizing the results of the screening process and study selection as per the PRISMA guideline

respirators. None of the guidelines took into consideration the optimization of the supply/utilization of PPE. Universal pre-operative testing was recommended in only 58.53% of cases and was not recommended in 26.82% of patients, while it was not mentioned in 12.19% of guidelines. The PPE recommendations did not vary with the emergency and routine settings.

## Discussion

HCPs are on the frontline in this war against the COVID-19 pandemic and are therefore most vulnerable to exposure from an infected patient. Such infections are as high as one in ten HCPs getting infected in some countries and many of them have succumbed to the infection. This is the reason for the focus on the safety of HCPs against accidental infection from their patients. PPE works as a barrier between an individual's skin, mouth, nose, or eyes, and viral/ bacterial infections, and includes gloves, medical masks, respirators, eye protection, gowns, aprons, and shoe covers. The use of PPE has been

shown to provide a high level of protection even in the face of heavy exposure in very high incidence areas like Wuhan, China [47]. The rapid global increase in the number of infected patients resulted in a shortage of PPE even in developed countries, while the health care systems in LMICs were put under severe logistics and economic pressure. As the end of this pandemic is still not in sight, a strategy has to be formulated for rational and appropriate utilization of PPEs to conserve resources for this long haul. This scoping review was conducted to evaluate the quality of current guidelines that emerged during the COVID-19 pandemic and how this crucial issue of PPE recommendations was addressed in a surgical setting.

A scoping review is an ideal approach to assess the nature and extent of research evidence and identify knowledge gaps promptly, especially for an on-going pandemic where knowledge, attitude, and practice are still evolving and are diverse. When evaluated by GRADE assessment, the level of the evidence was uniformly rated “low” in all guidelines (Table 1) [4]. As seen in the summary of their guidance on PPE in

**Table 1** The status of the recommendations on PPE during COVID-19 *Vis à Vis* guidelines of the societies included in the study (in order of evolution)

S. no.	Guideline	Country	LMIC	Date of publication	GRADE	E/R	Specialty	Hand Hygiene	Head cap	Front doffing gown	Face shield	Type of respirator	Donning described	Doffing described	EPPE by all staff	EPPE in a negative patient	EPPE in a positive patient	Disposal of PPE
1	RCOG BSGE [6]	UK	N	Mar-20	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
2	SIED [7]	Latin America	N	17-03-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	N	Y	NA
3	ERUS [8]	Europe	N	25-03-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
4	CAG [9]	Canada	N	27-03-2020	Low	E	MIS	NA	Y	Y	Y	Surgeon mask	N	N	Y	Y	Y	NA
5	FAAED [10]	Argentina	N	27-03-2020	Low	E	MIS	NA	Y	Y	Y	Surgeon mask	N	N	Y	Y	Y	NA
6	ISDE [11]	International	N	30-03-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
7	ABORL-CCF [12]	Brazil	Y	Apr-20	Low	Both	Oncosurgery	Y	Y	Y	N	N95	N	N	NA	NA	NA	NA
8	SERGS [13]	Europe	N	03-04-2020	Low	E	Gynecology	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
9	SASREG [14]	South Africa	Y	06-04-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
10	IIS (Italian) [15]	Italy	N	07-04-2020	Low	E	All	Y	Y	Y	Y	N95	Y	Y	Y	Y	Y	Y
11	WFO [16]	Global	N	09-04-2020	Low	E	MIS	NA	Y	Y	Y	N95	Y	Y	Y	Y	Y	NA
12	IFSO [17]	International	N	14-04-2020	Low	E	Metabolic	Y	Y	Y	Y	N95	NA	NA	NA	NA	NA	NA
13	AMEI [18]	Mexico	Y	15-04-2020	Low	E	MIS	NA	Y	Y	Y	NA	Y	Y	Y	Y	Y	NA
14	ESGE and ESGENA [19]	Europe	N	17-04-2020	Low	E	Endoscopy	Y	Y	Y	Y	Surgeon mask	NA	NA	N	N	Y	NA
15	ESTES [20]	Europe	N	17-04-2020	Low	E	Trauma	Y	Y	Y	Y	N95 OR PAPR	Y	Y	Y	Y	Y	NA
16	AFOP and SFORL [21]	France	N	18-04-2020	Low	Both	ENT	Y	Y	Y	Y	FFP2	Y	Y	Y	Y	Y	Y
17	USANZ [22]	ANZ	N	19-04-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
18	SAGES & EAES [23]	USA	N	22-04-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
19	ALSGBI [24]	UK	N	22-04-2020	Low	E	Gynecology	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
20	EAU [25]	Europe	N	27-04-2020	Low	Both	Urology	Y	Y	Y	Y	N95	NA	NA	N	N	Y	NA
21	SRED-ARCE [26]	Romania	N	01-05-2020	Low	Both	MIS	Y	Y	Y	Y	N95	Y	Y	Y	Y	Y	NA
22	AGES Nigeria [27]	Nigeria	Y	04-05-2020	Low	E	Gynecology	NA	Y	Y	Y	N95	N	N	NA	NA	Y	NA
23	SRS [28]	International	N	08-05-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
24	ELSA [29]	Asia	N	11-05-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
25	ASLS [30]	Argentina	N	13-05-2020	Low	E	MIS	NA	NA	NA	NA	N95	N	N	NA	NA	Y	NA
26	EHS [31]	Europe	N	23-05-2020	Low	E	Hernia	NA	NA	NA	NA	N95	N	N	NA	NA	Y	NA
27	AAGL [32]	USA	N	24-05-2020	Low	E	Gynae	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
28	IIS [33]	India	Y	05-06-2020	Low	E	General surgery	NA	NA	NA	Y	N95	N	N	N	N	Y	NA
29	BSGE [34]	UK	N	05-06-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
30	SGO [35]	USA	N	06-06-2020	Low	Both	Gynecology	Y	Y	Y	Y	Surgeon mask	NA	NA	N	N	Y	NA
31	SICOB [36]	Italy	N	08-06-2020	Low	E	Metabolic and GI	Y	Y	Y	Y	N95	N	N	Y	Y	Y	NA
32	ASI [37]	India	Y	09-06-2020	Low	E	General surgery	NA	NA	NA	Y	N95	N	N	N	N	Y	NA

**Table 1** (continued)

S. no.	Guideline	Country	LMIC	Date of publication	GRADE	E/R	Specialty	Hand Hygiene	Head cap	Front doffing gown	Face shield	Type of respirator	Donning described	Doffing described	EPPE by all staff	EPPE in a negative patient	EPPE in a positive patient	Disposal of PPE
33	HNCIG [38]	International	N	11-06-2020	Low	R	Oncosurgery	Y	Y	Y	Y	N95	NA	NA	NA	NA	Y	NA
34	BCS & BBMSS [39]	Brazil	Y	12-06-2020	Low	R	Metabolic	Y	Y	Y	Y	N95	Y	Y	Y	Y	Y	NA
35	TAES [40]	Turkey	Y	16-06-2020	Low	E	Emer. Surgery	Y	Y	Y	Y	N95	NA	NA	NA	NA	NA	NA
36	BCS [41]	Brazil	N	20-06-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
37	ESGE [42]	Europe	N	20-06-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
38	ACG [43]	USA	N	03-07-2020	Low	E	MIS	NA	Y	Y	Y	NA	Y	Y	Y	Y	Y	NA
39	BAUS [44]	UK	N	05-07-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
40	AGA [45]	USA	N	27-07-2020	Low	E	MIS	NA	Y	Y	Y	N95	N	N	Y	Y	Y	NA
41	ACHED & others [46]	Chile	N	NA	Low	E	MIS	NA	Y	Y	Y	Surgeon mask	Y	Y	Y	Y	Y	NA

LMIC low middle-income countries, GRADE grading of recommendations, assessment, development, and evaluations, E emergency, R routine, EPPE enhanced PPE, HAGP high aerosol generating procedure, Y recommended, N not recommended, NA information not available, MIS minimally invasive surgery, RCOG BSGE Royal College of Gynaecology-British Society for Gynaecological Endoscopy, SIED Interamerican Society for Digestive Endoscopy, ERUSEAU Robotic Urology Section, CAG Canadian Association of Gastroenterology, FAAED Federacion Argentina de Asociaciones de Endoscopia Digestiva, ISDE International Society for Diseases of the Esophagus, ABORL-CCF Brazilian Association of Otolaryngology and Cervicofacial Surgery, SERGS Society of European Robotic Gynaecological Surgery, SASREG Southern African Society of Reproductive Medicine and Gynaecological Endoscopy, IIS (Italian) International Inter Society Italian, WEO World Endoscopy Organization, IFSO International Federation for the Surgery of Obesity and Metabolic Disorders, AME Asociacion Mexicana de Endoscopia, ESGE and ESGENA European Society of Gastrointestinal Endoscopy and the European Society of Gastroenterology and Endoscopy Nurses and Associates, ESTES European Society of Trauma and Emergency, AFOP and SFORL French Association of Pediatric Otorhinolaryngology and French Society of Otorhinolaryngology, USANZ Urological Society of Australia and New Zealand, SAGES & EAES Society of American Gastrointestinal and Endoscopic Surgeons and The European Association for Endoscopic Surgeons, ALSGBI Association of Laparoscopic Surgeons of Great Britain and Ireland, EAU European Association of Urology, SRED ARCE Romanian Society of Digestive Endoscopy and the Romanian Association of Endoscopic Surgery, AGES Nigeria Association of gynecological endoscopy surgeons of Nigeria, SRS Society of Robotic Surgery, ELSA Endoscopic and Laparoscopic Surgeons of Asia, ASLS Argentine Society of Laparoscopic Surgery, EHS European Hernia Society, AAGL American Association of Gynecologic Laparoscopists, IIS Indian inter-society, BSGE British Society for Gynaecological Endoscopy, SGO Society of Gynecologic Oncology, SICOB Società Italiana di Chirurgia dell'Obesità e Malattie Metaboliche, ASI Association of Surgeons of India, HNCIG Head and Neck Cancer International Group, BCS & BBMSS Brazilian College of Surgeons and the Brazilian Bariatric and Metabolic Surgery Societies, TAES Turkish Association of Endocrine Surgery, BCS Brazilian College of Surgeons, ESGE European Society of Gastrointestinal Endoscopy, ACG American College of Gastroenterology, BAUS British Association of Urological Surgeons, AGA American Gastroenterological Association, ACHED & others Asociaciones Chilenas de Endoscopia Digestiva

Table 2, a major knowledge gap was lack of recommendations for optimizing the PPE use, conservation of resources, and advice on its donning/ doffing and disposal (Table 3).

Transmission of COVID-19 is believed to be predominantly *via* inhalation of droplets (10–100  $\mu\text{m}$ ) which are aerosolized during an expiratory event (breathing, talking, coughing, and sneezing) and gravitationally settle quickly. Some surgical procedures are high aerosol-generating procedures (HAGP); these are defined by WHO as medical procedures that are aerosol-generating and are consistently associated with an increased risk of pathogen transmission. Other equally important determinants of this risk are the duration of exposure, the proximity of HCP to aerosol, manipulation of high viral load tissue, and infectivity of organisms generated from the use of energy devices (laser, cautery, drills, micro-debriders, saws, and ultrasonic devices) [48]. This complex issue is further compounded by the debatable labeling of laparoscopy as high HAGPs for the risk of virus transmission [2]. Therefore, there is an urgent need to stratify HAGPs based not only on the type of surgery but also on incorporating other compounding factors too in the risk assessment [49].

“Mask” is the primary prophylaxis against droplet infection. Interestingly, the evolution of the “mask” has its roots in surgery, having been developed by Polish Surgeon Professor Jan Mikulicz-Radecki in 1897; who realized the importance of German bacteriologist Carl Flüggé’s discovery of droplets as a mode of transmission of disease. The generic term “mask” includes various specific types with different qualities: ordinary home-made cloth mask, 3-layer surgical mask, respirator variants with/ without valve (tight-fitting design to protect the

wearer, with a safety rating; the letters N and FFP/ P denote standardization by US Center for Disease Control and European Committee for Standardization respectively; the numbers after N/FFP/P denote filter capacity, i.e., removes x% of all particles that are 0.3 microns in diameter or larger) and powered air-purifying respirator (PAPR; headgear-and-fan assembly that actively filters pollutant/pathogen from ambient air then delivers the clean air to the user). Since surgical face masks filter particles larger than 0.1 to 5.0  $\mu\text{m}$ , it has been shown to provide adequate protection from transmission of COVID-19 in low-risk circumstances during previous respiratory virus epidemics [50]. However, a recent systemic review suggests that N95 respirators might offer better protection from viral transmission than surgical masks [51]. Similarly, a large variation exists in components of PPE with undefined classification/degree of protection by different types/best ways of its donning and doffing (to avoid any breach in bio-safety) and how to train HCWs to use PPE [52]. Such heterogeneity in classification and practice shows a lack of clear evidence.

Any decision making process for resource optimization (and thereby resource conservation) needs broad consensus on three issues: classification of surgical procedure into high or low risk (based on the degree of aerosol generation and HCP’s exposure), classification of PPE into “universal” respiratory precaution (for normal AGPs) or “specific” respiratory precautions (for high AGPs), and classification of a patient into COVID positive or negative (based on symptoms and best diagnostic modalities: RT-PCR and chest CT scan) [1, 51, 53–56]. Theoretically, universal preoperative testing helps

**Table 2** The distribution of the recommendations on PPE during the COVID-19 in the included studies ( $n = 41$ )

S. no.	Criteria	Recommended		Not recommended		Not mentioned	
		<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
1.	LMIC	8	19.51	33	80.48	0	0
2.	Hand Hygiene	13	31.70	0	0	28	68.29
3.	Gloves	37	90.24	0	0	4	9.75
4.	Head cap	37	90.24	0	0	4	9.75
5.	N95 respirator	34	82.92	5	12.19	2	4.87
6.	Front doffing gown	37	90.24	0	0	4	9.75
7.	Face shield	36	87.80	1	2.43	4	9.75
8.	Donning described	9	21.95	26	63.41	6	14.63
9.	Doffing described	9	21.95	26	63.41	6	14.63
10.	EPPE worn by all staff in OR	28	68.29	5	12.19	8	19.51
11.	Use of EPPE in a negative patient in OR	24	58.53	9	21.95	8	19.51
12.	Use of EPPE in a positive patient in OR	38	92.68	0	0	3	7.317
13.	EPPE in HAGP	30	73.17	1	2.43	10	24.39
14.	Disposal of PPE	3	7.317	0	0	38	92.68

LMIC low middle income countries, EPPE enhanced personal protective equipment, OR operation room, HAGP high-risk aerosol generating procedure, PPE personal protective equipment



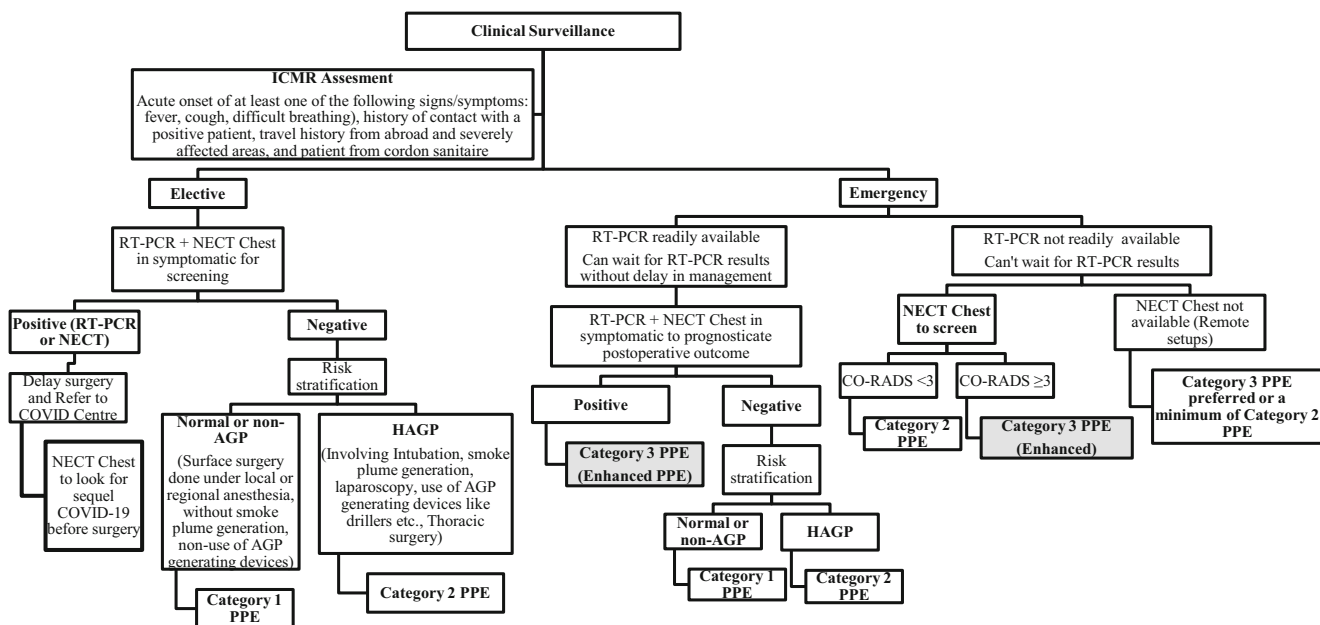
**Table 3** The identified gaps in the existing knowledge on the use of PPE and the practice recommendations based on scoping review

S. no.	Criteria	Existing knowledge gaps	Our practice recommendations
1.	Classification of PPE in a surgical setting	- The PPE has lot of variations and there is a need for categorization of PPE	<ul style="list-style-type: none"> <li>• Classification of PPE into ‘universal’ respiratory precaution (for normal AGPs) or ‘specific’ respiratory precautions (for high AGPs) is recommended</li> <li>• Categorization of PPE is needed</li> </ul> Category 1 PPE (Universal respiratory precaution) (N95/Surgical mask, Head cap, Cloth gown, Double latex gloves) Category 2 PPE (Reusable N95 respirator, Disposable Head Cap, Disposable, impermeable gown, Reusable Eye-shield, Reusable Face shield, Disposable shoe cover, Latex gloves with Nitrile gloves) Category 3- Enhanced PPE (All disposable, Coverall, N95/PAPR, Eyeshield, Face shield, Latex gloves with Nitrile gloves, Shoe cover)
2.	Rational use of PPE in a surgical setting	-The use of PPE is not optimized and used similarly for a positive, negative, and unknown status of the infection -PPE is used without assessment of the risk of infection concerning aerosol-generating procedure potential of the procedure -Due consideration has not been given for resource-constrained settings -Economic implications of irrational use of PPE are not studied	<ul style="list-style-type: none"> <li>• Classification of a patient into COVID positive or negative (based on clinical screening/ suitable diagnostic modalities: RT-PCR and Chest CT scan)</li> <li>• Risk stratification of the procedure according to aerosol generating potential should be followed a COVID-19 negative patient and PPE usage should be optimized.</li> <li>• The situations in emergency settings vary, therefore PPE recommendations may be different</li> </ul>
3.	PPE for a high AGP	-About 25% of the studies did not specify the need of PPE with reference to aerosol generating potential of the procedure	‘Specific’ respiratory precautions are recommended, however, due consideration need to be given to preoperative status of infection with reference to use of EPPE (Category 3)
4.	PPE for Non-AGP	-Majority of studies recommended EPPE irrespective of aerosol generating potential.	A minimum of ‘Universal’ respiratory precautions are recommended, however, due consideration need to be given to preoperative status of infection with reference to use of EPPE (Category 3)
5.	PPE for a negative patient	-Majority of studies recommended EPPE irrespective of preoperative testing results.	Category 1 PPE for NAGP and Category 2 PPE for AGPs is recommended
6.	PPE for a positive patient	- Majority of studies recommended EPPE irrespective of preoperative testing results.	Category 3- Enhanced PPE is recommended
7.	PPE for resource--constrained setting	-Most of the guidelines have not addressed the issue about resource-constrained settings where there is a shortage or unavailability of testing, CT scan or EPPE	A minimum of category 2 PPE is recommended, however, a “universal” respiratory precaution is doable in NAGPs.
8.	Use of PPE for operation room staff	Majority of the studies recommended use of EPPE by all staff in the operation room	Use of PPE need to be optimized by reducing no of staff persons in OR, and use of recommended PPE.
9.	Optimization strategies of PPE	-The crucial issue of optimization of PPE was conspicuously missing. The use of PPE has largely been guided by fear over science and not based on the possibility of transmission with respect to preoperative testing, imaging, and aerosol-generating potential of the procedure.	Risk stratification and PPE optimization strategy are recommended (Figure 2). However, the impact of the proposed algorithm needs to be studied prospectively and validated qualitatively.
10.	Efficacy of PPE	It was found to have direct correlation with donning and doffing technique	Strict donning and doffing techniques, use of ‘buddy’ technique should be adopted
11.	PPE Disposal	Only 3/41 studies reported the importance of PPE disposal	Strict hospital waste disposal policy should be followed

to categorize the surgical patients into COVID positive or negative, but the two most commonly used diagnostic modalities: RT-PCR and CT scan Thorax do not have 100% accuracy [57, 58]. Surprisingly, none of the 41 guidelines for surgery during this COVID pandemic addressed the crucial issue of optimization of PPE use; routine versus emergency

settings, consideration of clinical surveillance, and none of the guidelines even from LMICs have any advice for temporary measures in the context of PPE shortage or reusability of PPEs.

To sum up, this scoping review of guidelines for surgery has brought out certain gaps in available research evidence:



**Fig. 2** A simple decision-making algorithm for use of PPE in different surgical settings during COVID-19, based on the knowledge gaps found in the scoping review

1. When assessed by GRADE, the level of evidence was uniformly rated “low” in all guidelines.
2. The crucial issue of optimization of PPE has not been addressed at all and is conspicuously missing.

This can serve as a richly informed starting point for further conceptual work in the field of research, practice, and policy. This pandemic has caused major disruption to the health economics of all countries, barring none. This alone calls for the optimization of PPE and the conservation of resources. Surgeons are considering rebooting elective surgery wherever the pandemic has plateaued [59]. Much needed research on such an important topic should be part of the continuation and rebooting of surgical services. A simple decision-making algorithm can be constructed, based upon this scoping review which can allow HCWs to walk the tightrope between safeguarding themselves and optimizing/conserving resources (Fig. 2). This algorithm addresses all the limitations of guidelines observed in this scoping review.

Results of our scoping review are not meant as a critique of these guidelines; however, only a rigorous evidence base will make these guidelines more reliable. Additionally, easy understanding, resource availability, geographical implications and economic implications part of any recommendation has to be addressed, especially for LMIC which is facing the major brunt of the pandemic [3, 60]. The Association of Surgeons of India has led from the front in this war against the COVID-19 pandemic. Formulation and timely revision of guidelines on this contemporary and vitally important topic, incorporating the economic needs of LMICs, will further enhance ASI’s

eminence and will be of immense help for all the surgeons working in LMICs. This scoping review can provide interim guidance and act as the stepping stone for the development of such a guideline.

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**Data Availability** Available

### Compliance with ethical standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Code Availability** Not applicable

**Ethics Approval** Obtained

**Consent to Participate** Not applicable

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