

Personal Protection Equipment for Endoscopy in Low Resource Settings during the COVID-19 Pandemic: Guidance from the World Gastroenterology Organisation.

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Purpose

We wish to provide guidance with regard to the utilisation of Personal Protection Equipment (PPE) for the prevention of infection from COVID-19 in health care workers performing gastrointestinal endoscopy, with special reference to low resource situations.

Background and Rationale

Endoscopic procedures will be indicated in some patients who are infected with COVID-19, or whose status is unknown. These procedures pose a transmission risk to the physicians, nurses and technicians involved¹. Prevention of infection of health care personnel is important in the management of the COVID-19 pandemic since the infection is associated with significant morbidity and mortality and health resources are finite. The procedures also pose a SARS-CoV-2 infection risk to the patient who may be exposed to the virus facility from staff, including the endoscopy personnel.

COVID-19 is spread by four means: contact with an infected surface or object, by droplets, by aerosols and probably by faeco-oral route². Endoscopy units are a suitable environment for disease transmission by all of these routes. Strategies to prevent infection need to be considered with regard to these modes of transmission in three phases: Pre, Intra, and Post endoscopic procedure. Health care worker protection involves more than PPE; hand washing, for example, to prevent contact transmission is an integral part of safe practice.

Ideally, appropriate and optimal PPE would be used in every procedure. However, PPE shortages have emerged as a key issue in the pandemic and this will be particularly problematic in developing world countries. In order to optimize the use of PPE during this pandemic it is necessary to define both the level of risk and the appropriate PPE defence.

The World Gastroenterology Organisation (WGO) mission focuses on the developing world and low resource localities. WGO Cascades are guidelines formulated to outline options stratified by high, medium and low

resource situations³. In the current COVID-19 pandemic even traditionally high resource countries have faced equipment shortages requiring them to adopt strategies based on low resource realities⁴. This cascade will outline the ideal resources when no equipment restrictions are in place, and the options for when restrictions on ideal practice occur.

What is optimal PPE for Endoscopy?

Upper endoscopy, including ERCP, is associated with the generation of aerosols from the upper GI tract and airways⁵. SARS-CoV-2 is a pathogen which primarily infects the gastrointestinal and respiratory tracts. Aerosols containing the virus pose a risk of infection to medical personnel. In addition, surfaces and equipment in the endoscopy room environment may be contaminated by droplets and direct contact⁶.

Although there is less data on the risk of transmission from lower GI tract procedures, SARS-CoV-2 virus can be detected in stool in up to 48% of COVID-19 patients and some have proposed that precautions (See Table 1) should be taken for lower GI tract examinations⁷. Infected patients will contaminate the environment with virus particles which can last for many hours.

In order to define what may be acceptable in low resource settings we first need to define what is optimal in non-restricted resource settings. A recent systematic⁸ review concluded that the evidence is limited because the studies simulated infection, and they had a small number of participants. The authors also stated that covering more of the body leads to better protection. However, as this is usually associated with increased difficulty in putting on and removing PPE, and the PPE is less comfortable, it may lead to more contamination and may even interfere with procedure effectiveness. Coveralls are the most difficult PPE to remove but may offer the best protection, followed by long gowns, gowns and aprons. Respirators worn with coveralls may protect better than a mask worn with a gown, but this form of PPE is more difficult to put on. More breathable types of PPE may lead to similar levels of contamination to coveralls but be more comfortable. A balance needs to be struck between the amount of PPE worn, comfort in use and contamination when it is being removed.

What is the minimal PPE required for endoscopy in low resource settings?

(See Appendix 1 for Local Manufacture of PPE)

Many developing countries struggle to provide even basic PPE⁹ however there is a minimum requirement for PPE utilized during endoscopy beyond which medical team safety is compromised. Scrubs, hair covering, gowns, faceshield, and/or goggles, gloves and foot protection are basic requirements. These are not expensive and can be sourced or manufactured locally.

Masks and Respirator Masks.

Masks are a key component of PPE¹⁰. A surgical mask is a loose-fitting, disposable device that creates a physical barrier between the mouth and nose of the wearer and potential contaminants in the immediate environment. Surgical masks differ in thickness and other properties that may affect ease of breathing and protective abilities. They are intended to help protect the wearer by blocking large-particle droplets, splashes, sprays or splatter that may contain viruses and bacteria and to help protect others by reducing their exposure to the wearer's saliva and respiratory secretions. Surgical masks do not provide complete protection because they do not filter very small particles and they do not fit very closely against the face.

A respirator mask is a protective device designed to achieve a very close facial fit and very efficient filtration of airborne particles. The 'N95' designation means that when subjected to careful testing, the respirator blocks at least 95 percent of very small (0.3 micron) test particles. If properly fitted, the filtration capabilities of N95 respirators exceed those of face masks. However, even a properly fitted N95 respirator does not completely eliminate all risk. Respirators capture particles through mechanical and electrostatic mechanisms. They are rated by their efficiency. N95, N99 and N100 capture 95%, 99% and 100% of particles respectively¹¹. Respirator masks cannot be made without specialized equipment.

The FFP2 mask is the equivalent of N95 and the FFP3 equates to N99. Cloth masks do not meet the minimum level of protection for health care workers and may result in a health care worker becoming infected and spreading disease. We do not recommend that cloth masks be used by health care providers in a health care setting.

For the purposes of this document respirator refers to N95, FFP2, FFP3 or higher levels of protection. PAPR (Powered Air Purifying Respirator) systems are effective but are not in widespread use.

Variables used in the formulation of recommendations.

Four inter-related variables guided the committee's formulation of the recommendations.

1. The Incidence of COVID-19 varies markedly from country to country and even within countries. Incidence numbers are determined by disease burden and by the extent of testing. It has become clear that the majority of infections are asymptomatic and will not be detected without population testing. There is no clear demarcation between high and low incidence. In the context of endoscopy, a single infected patient in a low incidence setting may result in considerable morbidity. Nevertheless, guidelines especially in resource constrained settings, need to accommodate the level of risk when distributing limited PPE resources.
2. The availability of PPE is related to disease burden since disease burden will result in increased utilization and to local resources. Countries vary markedly in their ability to provide PPE to health care providers. A high incidence of disease may precipitate shortages. Multiple items of PPE are required to perform endoscopic procedures safely. Shortages of even a single component may jeopardize safety.
3. The likelihood of a patient being infected with COVID-19 depends on the individual patient's risk factors and clinical state and the background incidence of disease. Determination of whether a patient is infected

or not is difficult without access to rapid PCR and antibody testing. There is currently no data on the sensitivity and specificity of questionnaires and temperature checks in the detection of COVID-19. A patient's likelihood of infection with COVID-19 changes the level of PPE used and the frequency with which PPE is discarded.

4. There is disagreement on whether endoscopic procedures on the lower GI tract constitute the same level of risk as upper GI procedures which pose a higher risk of generating aerosols.

It is not possible to formulate highly prescriptive recommendations in such a complex, dynamic situation especially given the paucity of evidence. Instead we have attempted to formulate recommendations which will act as guides and permit localized, customized decisions on PPE. These will be updated as experience and evidence evolves.

Comparison with other Societal recommendations.

Many national societies have prepared guidance for the use of PPE for endoscopy during the COVID-Pandemic. In order to give context to the WGO guidance the recommendations of some of these societies are summarized in Table 1 and contrasted with those of the WGO.

Methodology

The Research Committee of the WGO reviewed the literature and national guidelines with special reference to low resource countries. A literature search was conducted on PPE, and endoscopy in low resource settings. The literature results were shared with all members. Owing to resources and time constraints, no preliminary PICO-based statements were formulated; neither the level of evidence nor recommendations were formally graded, but the group followed a modified Delphi consensus process to produce the recommendations.

Only low-very-low evidence for the most part was identified which might guide recommendations in this setting. The recommendations for low resource settings are, therefore, based on expert opinion. Much of the published literature on COVID-19 and endoscopy is in the form of preprints and may not have been peer reviewed. However, the guidance here is from a global group of seventeen clinical and research experts from developed, and developing, world countries.

When the committee members were not unanimous on a recommendation the issue was put to a vote with 60% in favor being taken as the threshold for acceptance of a recommendation.

Twenty headline recommendations were generated, and 57 sub recommendations, for PPE use in high and low resource situations. These cover PPE conservation and use of in Pre-procedure, Intra Procedure, Post Procedure and the return towards normal endoscopy unit function.

Recommendations

Pre-Procedure

1. Triage referrals. Reduce the number of endoscopies being performed, delay elective procedures.

Rationale: A reduction in non-urgent procedures may reduce the risk of infection to non COVID-19 patients, and to medical personnel, and will conserve PPE.

Triage of all procedures should be done by trained medical personnel¹².

1.1 Triage referrals based on level of urgency.

1.2 Procedures which are not time-sensitive should be postponed.

1.3 Carry out regular subsequent monitoring of postponed patients to ensure that their condition does not become urgent.

Low resource: Same

2. Reduce COVID-19 burden.

Rationale: Hospitals and health care facilities are high risk areas for contracting COVID-19.

2.1 Keep patients away from health care facilities as much as possible.

2.2 Provide online or telephone care for patients prior to attending the hospital

2.3 Reschedule non time-sensitive procedures and follow up.

Low resource: Same

3. Screen all endoscopy patients for COVID-19 and stratify into low or high risk of infection.

Rationale: Screening patients and stratifying infection risk into higher and lower will allow conservation of higher-level PPE, such as respirators¹. On the other hand, it may induce a false sense of security since even with the most rigorous screening, asymptomatic infected patients may be classified as low risk, and treated as such, with subsequent risk to health personnel; even PCR testing carries a false negative risk that can be significant.

Low risk patients are those from a low incidence area, with no history of contact or travel, no symptoms and no signs.

3.1 Stratify patients by risk level.

3.2 Perform screening by questionnaire and temperature checks.

3.3 If possible, supplement this with serological or PCR testing¹³.

Low resource:

3.4 In areas of low incidence of infection, and with a low risk patient as determined by screening, it is reasonable to perform lower GI procedures with less than the highest level of PPE.

3.5 The minimum level of PPE even for a patient triaged as low risk includes scrubs, hair covering, long waterproof gown, boots, face shield, or goggles, reused respirator or surgical mask.

4. Patients should wear masks on entry to the healthcare facility. Reduce the risk of transmission from infected, or potentially infected patients.

Rationale: Patients may be vectors for the disease and may infect other patients, health care providers, and contaminate the environment⁶.

4.1 All patients should wear a surgical mask and disinfect their hands.

4.2 Keep a physical barrier, such as glass, between the nurse doing pre procedure interviews and the patient¹⁴.

4.3 If a glass barrier is not available, the interviewer should wear eye protection.

4.4 The interviewer should wear a surgical mask and gloves for any contact with low risk patients and full PPE for contact with those suspected or known to be infected.

4.5 Caregivers and relatives should be prohibited from the endoscopy department unless necessary¹⁴ such as, for example, attending procedures on minors or accompanying patients who cannot give consent, or in the case of a language barrier.

Low resource:

4.6 As above from 4.1 – 4.5

4.7 Patients who are at low risk of COVID-19 can wear a cloth mask instead of a surgical mask. The effectiveness of cloth masks is questionable, but a clean, recently washed mask may offer some protection against droplet spread and limit contamination of the health care environment^{15,16}.

5. Minimize the risk of patients acquiring infection.

Rationale: Health care facilities are high risk areas for transmission of infection to non-infected individuals. Infection could be acquired from a contaminated environment, other patients or from health care providers.

- 5.1 Practice physical distancing in the endoscopy unit. Space out chairs and recovery beds.
- 5.2 Arrange procedure start times to minimize congestion
- 5.3 Instruct staff to stay home if symptomatic or an unprotected contact with an individual with COVID-19

Low resource: Same

6. Minimise staff exposure.

Rationale: Usage of PPE can be reduced by minimising the number of personnel in the room. This will also help reduce infection in staff by minimising exposure to aerosol and contaminated surfaces and avoid possible simultaneous large-scale quarantining of staff with subsequent personnel shortage.

- 6.1 Keep the number of staff in the procedure room to a minimum.
- 6.2 Plan to bring into the room what you need before you start the procedure so that staff do not need to leave or enter.
- 6.3 Do not switch staff during the list, or during procedures as PPE will need to be removed. This wastes PPE and risks contamination.
- 6.4 Do as much documentation, as possible, outside the room, away from the patient.
- 6.5 Do not take personal belongings such as phones or stethoscopes into any procedural area as these may become contaminated¹².

Low resource: Same

7. Train all staff in the correct use of PPE (Appendix 2)

Rationale: PPE is only effective if the right equipment is used in the right way for the right indication. Incorrectly donned PPE, such as an incorrectly fitted respirator, reduces PPE effectiveness and increases the risk of infection from COVID-19. Incorrect removal of PPE risks contaminating the user and the workspace. Correct procedure for donning and doffing is essential¹⁸.

- 7.1 Review and observe staff practicing PPE donning and doffing PPE.
- 7.2 Make sure that staff have been fitted for respirators if possible⁶. See Appendix 1.
- 7.3 Emphasize the importance of meticulous hand hygiene.
- 7.4 Create an area adjacent to the endoscopy rooms where PPE can be safely donned and doffed.

Low resource: Same

8. Do not involve trainees in procedures on patients with a high risk of COVID-19

Rationale: This will reduce trainee risk of infection, conserve PPE, and provide a physician reserve which may be utilised if necessary, if attending staff become ill. The difficulty is that many patients with COVID-19 are asymptomatic. Some patients, such as those with a positive RNA PCR, clearly have the disease and trainees should be excluded. Such a policy will also optimize effectiveness while minimizing procedural times and thus exposure of the personnel.

Low resource: Same

Intra Procedure

9. Wash Hands

Rationale: Contaminated hands may transfer the virus to eyes or mouth. Wash hands properly with soap for 20 seconds or use an alcohol based disinfectant, before and after each procedure, after contact with potentially infectious sources, before putting on PPE, and after removal of PPE. Gloves are not a substitute for proper hand hygiene¹.

Low resource: Same

10. Use a respirator for all upper procedures (See Appendix 3 for guidance on reuse)

Rationale: Respirator masks represent optimal mask protection especially for aerosol generating procedures.

10.1 Do not discard the respirator between cases unless the endoscopy has been performed on a patient diagnosed with COVID-19 or highly likely to have the disease. See Appendix 3 for guidance on extended use or reuse of respirators.

Vote: 36 % were in favor of changing the respirator between all cases even in low resource settings.

Low resource:

10.2. Where feasible collect used N95 respirators that are not visibly soiled or damaged so that they may be reprocessed for future use using appropriate sterilization and decontamination methods²⁰.

11. Use a respirator for lower GI procedures in high resource settings only

Rationale: The virus is detectable in the stool of infected patients⁷. Lower GI tract procedures represent a risk of contamination of both the environment and the endoscopist. Aerosolization may be less than with upper procedures but may occur with removal of instruments from the biopsy channel. There is evidence of virus shedding into the air from infected patients simply by breathing. It is likely that the air in the endoscopy room will be contaminated further justifying the use of a respirator in this setting. Face shields may help extend the life of respirator stock by preventing contamination.

Vote: 71% in favor.

11.1 Do not discard the respirator between cases unless the procedure has been performed on a patient diagnosed with COVID-19 or highly likely to have the disease.

11.2 Use a face shield and goggles with the respirator.

Low resource:

11.3 Use a surgical mask during lower GI procedures on low risk patients.

Vote: 50% in favor of using respirators in lower GI procedures in low resource settings, this was not adopted.

12. Use surgical masks only in low risk patients in low resource settings.

Rationale: Surgical masks are made of non-woven materials such as cellulose polypropylene. They are designed to stop large droplet contamination from the user, but they are not designed to effectively filter particles less than 3 microns in size. COVID -19 has a diameter of 0.15 microns. As discussed above in Recommendation 3 the concept of low risk patients may not be valid.

Low resource: Same

13. Wear a single pair of gloves.

Rationale: For health care workers performing any GI procedure, regardless of COVID-19 status, some organizations recommend the use of double gloves compared with a single pair. There is some support for reduced contamination with double gloves¹⁷. The outer glove is removed, then the respirator and goggles are removed using the clean glove, and then the second glove is taken off.

Vote: 57% voted for use of two pairs of gloves. The recommendation is for a single pair.

Low resource:

13.1 In low resource settings, as for high resource settings, a single pair of gloves with meticulous hand washing is acceptable practice.

50% voted for use of two pairs of gloves in this setting.

13.2 Regardless of whether one pair, or two, are used it is important that there is no gap between glove and gown¹⁷. Gowns with thumb loops may help in this regard.

14. Wear a face shield.

Rationale: Face shields will protect the mask, eyes and face from splatter¹⁸ but will not protect from aerosols. Face shields are not difficult to manufacture. See Appendix on manufacture of face shields.

Vote: 86% in favor.

14.1 Disinfect between each case.

Vote 85% in favor

14.2 Face shields do not need to be combined with goggles.

Vote 21% in favor of combined goggle and face shield use.

Low resource: Same

15.Wear Goggles

Rationale: COVID-19 infection may be acquired through the conjunctivae, certainly the virus can be found in tears. We do not know if aerosolized COVID-19 is infectious through the conjunctivae. If it is, only goggles will be protective from infection through the eyes and, a face shield alone may not suffice. It is likely that the virus can be transmitted through the conjunctivae if the eyes are touched by contaminated hands. This provides additional rationale for using goggles¹⁹.

Vote 86% in favor.

15.1 Use reusable, or disposable, goggles to prevent infection.

15.2 Disinfect the goggles between lists and after use in an infected patient.

Vote: 36% voted for disinfection between each case.

Low resource: Same

16.Wear scrubs, a gown and hair protection

Rationale: The objective of PPE is to create a barrier between the virus and the health provider. Contaminated clothes and skin and hair may lead to infection as contaminated hands touch the eyes or lips.

16.1 Wear scrubs and do not bring them out of the health center.

16.2 Wear a long waterproof gown.

16.3 Cover the skin of the neck and cover the hair.

16.4 Discard the gown between each case. This may help reduce infection to the health care provider from a contaminated gown, and transmission to non-infected patients, but will result in increased usage of PPE.

The committee voted 79% in favor of discarding gowns between use.

Low resource:

16.5 In low risk patients, a disposable plastic apron can be worn over the gown. This can be discarded between cases, and the gown retained, allowing extended use of the gown. See **Appendix 1** on local manufacture of gowns in situations of extreme shortage.

The committee voted 50% in favor of discarding gowns in low resource settings.

16.6 Consider switching to reusable isolation gown options, wherever possible. These can be washed and disinfected in a hospital laundry²⁰.

17. Wear work footwear

Rationale: There is ample evidence that the environment around an infected patient is contaminated. That includes the floor²¹. The virus can be tracked to other areas.

17.1 Change into work boots or dedicated washable shoes that are kept in the endoscopy unit staff changing room.

17.2 Wear disposable plastic, not cloth, longer length shoe covers.

17.3 Disinfect the boots worn in the endoscopy room in disinfectant bath at the end of the endoscopy session and do not take them out of the work area.

Low resource:

17.4 Shoe covers can be avoided by wearing boots which can be disinfected.

18. Ventilate the air in the endoscopy room.

Rationale: COVID-19 is shed into the air by infected patients. Aerosols containing the virus may be created during upper GI procedures. Aerosolized virus poses a risk to medical personnel. Reducing the concentration of virus in the air and preventing contamination of the air in adjacent rooms is a reasonable objective. Negative pressure rooms may help stop the spread of aerosols containing the virus to other areas of the facility. It is

reasonable to use negative pressure rooms if available, but they are not essential. Negative pressure rooms are not widely available in low resource countries.

18.1 Use a negative pressure room if it is available.

18.2 When negative pressure rooms are unavailable, portable industrial-grade high-efficiency particulate air (HEPA) filters are a reasonable alternative to negative pressure rooms and can be used without a room filtration system.

18.3 Ensure that air conditioning is not in recycle mode.

18.4 Delay allowing a new patient in the room 30 minutes for negative pressure rooms) and 60 minutes in the absence of negative pressure rooms¹. Rooms differ in the amount of airflow and this should be determined for each unit. This will allow some time for aerosols of the virus to disperse.

Low resource:

18.5 If HEPA are not available, adequately ventilate the procedure room to the outside by opening windows or using a fan to blow air to the outside.

Post Procedure

19. Endoscopy reprocessing staff should utilize PPE.

Rationale: Reprocessing staff are exposed to contaminated scopes and should wear personal protective equipment (PPE) that includes gloves, gown, face shield, and surgical mask. Surgical mask may suffice since aerosol should be less than in the procedure room. While there is no data to support a requirement for the use of respirators in the reprocessing room, their use should be considered, if available²².

Low resource: Same

20. Endoscopy room cleaning staff should utilize PPE.

Rationale: The area where a procedure has been performed on a COVID-19 infected patient, the recovery area and washrooms will be contaminated⁶. Aerosol should be reduced compared to procedure time so a surgical mask may be adequate for workers in this situation. Staff involved in the cleaning of endoscopy rooms should utilize PPE. This should include head cover, gown, surgical mask, eye-protection, foot coverings and gloves.

20.1 Given the contamination of the endoscopy environment it is necessary to perform meticulous cleaning of room after each procedure.

Low resource: Same

Returning to usual practice after the COVID-19

We have provided guidance with regard to the utilisation of Personal Protection Equipment (PPE) for the prevention of infection from COVID-19 in health care workers performing gastrointestinal endoscopy, with special reference to low resource situations. Once the initial phase of the pandemic is over it will be necessary to plan the reopening of endoscopy units and to revise triage criteria. This has implications for PPE and will be the subject of a separate report.

Acknowledgement.

The literature searches were carried out by Justus Krabshuis of the WGO “Ask a Librarian” service. This service is available for free for those interested in or working in the fields of Gastroenterology, Hepatology and Endoscopy in LMIC countries. We are very grateful for his help.

<https://www.worldgastroenterology.org/forms/ask-a-librarian.php>

Society	WGO	AGA	APSDE	BSG	CAG	ESGE, ESGNA	SGEI, ISG, INASL
1. Triage	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Reduce	Yes	NA	Yes	Yes	Yes	Yes	Yes
3. Screen, stratify risk	Yes	NA	Yes	Yes	Yes	Yes	Yes
4. Reduce risk from patients	Yes	NA	NA	NA	NA	Yes	Yes
5. Reduce risk to patients	Yes	NA	NA	NA	NA	Yes	Yes
6. Minimize staff exposure	Yes	Yes	Yes	Yes	NA	Yes	Yes
7. Train staff in PPE use	Yes	Yes	Yes	Yes	NA	Yes	Yes
8. No trainees in room	Yes	Review	NA	Yes	NA	NA	NA
9. Wash hands	Yes	NA	Yes	Na	NA	Yes	Yes
10. Respirator for Upper	Yes	Yes	Yes HRC	Yes FFP3	Yes	HRC only	Not specified
11. Respirator for lower	HR only	Yes	Yes HRC	Yes HR	No LRC	HRC only	Not specified
12. Use Surgical mask	LR, LRC only	No	Yes LRC	NA	Yes LRC	LRC only	Not specified
13. Double glove	No	Yes	No	No	Yes LRC	HRC only	NA
14. Wear Face shield or Goggles	Yes	NA	Yes	Yes*	Yes HRC	Yes	Yes
15. Wear Goggles or Face shield	Yes	NA	Yes	Yes*	Yes	Yes	Yes
16. Wear a Gown and hair cover	Yes	NA	Yes	Yes	Yes	Yes	Yes
17. Wear Work footwear	Yes	NA	NA	Yes	NA	NA	NA
18. Ventilation of endoscopy room	Yes	Yes	Yes HRC	NA	NA	Yes	Yes
19. Reprocessing staff wear PPE	Yes	NA	NA	NA	NA	Yes	NA
20. Cleaning staff wear PPE	Yes	NA	NA	NA	NA	NA	NA

Table 1.

Summary of evidence from selected National and International Societies compared to WGO recommendations. Yes - Recommended, No - Not recommended, NA - indicates Not Addressed. HR - High Resource. LRC - Low Risk of COVID-19, HRC - High Risk of COVID-19.

WGO - World Gastroenterology Organisation.

AGA - American Gastroenterological Association¹², APSE – Asian Pacific Society for Digestive Endoscopy²³, BSG - British Society of Gastroenterology²⁴. CAG - Canadian Association of Gastroenterology²⁵.

ESGE, ESGNA – European Society of Gastrointestinal Endoscopy, European Society of Endoscopy Nurses and Associates¹⁴. SGEI, ISG, INASL -Society of Gastrointestinal Endoscopy of India, Indian Society of Gastroenterology, Indian Society for Study of the Liver.²⁶

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Appendix 1

Local manufacture of PPE in limited resource settings.



Optimal PPE for endoscopy: Hair covering, protective glasses, faceshield, N95 mask with covering surgical mask, scrubs, long disposable plastic gown, disposable foot coverings, gloves. Courtesy Dr Harshit S. Khara, MD. Clinical Associate Professor of Medicine, Geisinger Medical Centre, PA, USA.

What is currently felt to be optimal PPE is illustrated above. In extreme situations it may be necessary to innovate. The evidence base for the optimal equipment is weak⁸. The evidence base for innovative equipment does not exist. The risk of performing procedures with novel fabricated PPE has to be weighed against benefit. Given WGO's mission and focus on low resource settings some of these innovations are described here but extreme caution is urged. If possible, consider referral to centres with adequate PPE before resorting to non-standard PPE.

Hair covering and scrubs

These can be manufactured from a variety of washable, synthetic and natural materials.

Face shields

These can be made from a variety of materials available in home or office.

<https://www.themachinemaker.com/innovation/face-shield-mahindra-ford-innovation-covid19>

<https://www.dezeen.com/2020/04/03/mit-covid-19-face-shields-design/>

<https://www.youtube.com/watch?v=fsU3wyLELI>

Masks

Respirators can be reused. (See Appendix on reuse). In low resource settings mask rotation is likely to be most applicable. If respirators are not available, surgical masks in combination with face shields may be used in specific circumstances as outlined in the Recommendations, together with modification of airflow (by fans or other means) to decrease exposure to aerosols and droplets, but the efficacy of this strategy is unknown. Cloth masks are acceptable for low-risk patients during pre-procedure assessment but are not adequate for healthcare staff during endoscopy procedures.

Boots

Plastic or rubber boots are widely available and can be disinfected post use.

Gowns and aprons. A method to manufacture disposable plastic covering has been described from South Africa. http://ihpublishing.co.za/wp-content/uploads/2020/05/SAGES_Volume18_Issue1_digital.pdf

Rapid emergent changes in the Upper Gastrointestinal Endoscopy Service routines at Groote Schuur Hospital with COVID-19

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Community spread of COVID-19 is now established in South Africa and recent data from China suggests up to 80% of infected individuals possibly being asymptomatic and thus an important possible source of contagion. Upper gastrointestinal (GI) endoscopy is considered a high-risk procedure, as it carries the potential of aerosolizing the SARS-CoV-2 virus.^{1,2} This has prompted our local endoscopic practice to change dramatically in a short space of time.

All patients arriving at the endoscopy unit are formally screened for exposure and symptoms of COVID-19. Indirect measures to decrease risk of exposure to healthcare workers, decrease community spread and allow for staff redeployment have led us to cancel all elective and non-urgent upper and lower GI endoscopies with immediate effect. Every endoscopic procedure is now assessed on a case-by-case basis, with the vast majority of diagnostic endoscopies deferred. At present our only considered indications for gastroscopy are upper GI bleeding needing endoscopic intervention, oesophageal stenosis or dilatation for high-grade dysphagia and gastric outlet obstruction amenable to endoscopic laser resection.

Biliary decompression in patients with obstructive jaundice is limited to patients with cholangitis or symptomatic jaundice refractory to medical management. Where possible percutaneous transhepatic cholangiography (PTC) with biliary drainage, a lower risk procedure, is preferred. Endoscopic retrograde cholangiopancreatography (ERCP) is reserved for patients with contraindications for PTC, or after failed PTC. Further indirect measures include restricting staff exposure to endoscopy with only a limited number of designated, experienced endoscopists who rotate on a daily basis performing these urgent services. Presently we no longer perform any endoscopic training and allow only the endoscopist and two nursing staff into the endoscopy suite.

We believe a safe working environment for our endoscopic team is of paramount importance. In view of the potentially asymptomatic, yet infective, patient population,

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the suboptimal sensitivity of the available screening tests, and the significant contagious nature of this novel coronavirus, and in line with international guidelines, every Upper GI endoscopic procedure performed in our unit is done with full personal protective equipment (PPE). The ESGE guidelines³ suggest the following PPE requirements for endoscopy in all high-risk patients: disposable hairnets, face shields/goggles, N95 (or similar) respirator masks, waterproof disposable gowns and two pairs of disposable gloves. PPE is now a globally scarce resource with needs likely to escalate. As in many countries, in particular those with resource-constrained health systems sourcing of some PPE materials has become the responsibility of the endoscopist and innovative on-site fashioning of own PPE kits has become widespread.

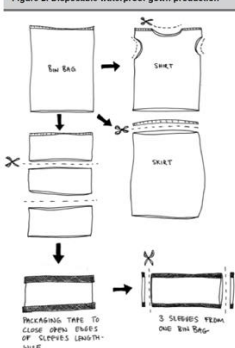
In our setting we were from the onset faced with limited availability of some PPE items, such as appropriate protective eyewear, N95 masks and disposable gowns. We thus sourced our goggles from agricultural and hardware stores (these are actually designed for pesticide crop spraying and seal well around the eyes). We have decided

Figure 1. N95 rotation system



ORIGINAL

Figure 2. Disposable waterproof gown production



to reuse our N95 masks in a 1-in-4 sequential daily rotation system (Figure 1). As per a SAGES advisory statement⁴, this involves wearing one mask for the entire endoscopy list and then allowing it to hang for 72 hours before being used again. In confirmed COVID-19 cases, N95 masks are not reused.

Our main concern remains the lack of available disposable waterproof gowns. We have thus taken to fashioning our own gowns using plastic bin liners, as has previously been described from areas of high COVID-19 incidence.^{5,6} Figures 2 and 3 demonstrate our production and donning thereof. A plastic apron is then worn over the "gown", with gloves and apron being changed between patients. If a suspected or confirmed case presents for endoscopy, the entire "gown" is changed. The doffing technique is of utmost importance and requires an assistant with scissors slitting the "gown" from behind such that it can be removed in one piece without contaminating the wearer or environment (Figure 3). Standard cleaning techniques for the reprocessing of endoscopes and accessories with commonly used virucidal disinfectants are adequate in inactivating the COVID-19 virus, and as such should be performed as per previously published guidelines.⁷ Single-use endoscopic devices should not be reused.

In addition, in aiming to reduce aerosolization of secretions, all endoscopies are performed at a minimum with conscious sedation. This is presently achievable due to the significant decrease in the number of endoscopies performed in our unit. Confirmed or suspected COVID-19 positive

Figure 3a. Donning "shirt and skirt"



Figure 3b. "Sleeves" attached at front of shoulders with tape, and fitted with elastic bands at the wrists; two pairs of gloves worn



Figure 3c. Assistant cutting "gown" off from the back



Figure 3d. Careful doffing of "gown" as a single unit



Figure 4. Plastic sheet with small hole allowing for endoscope passage only



Figure 5. Endoscopy team making gowns



patients should ideally be done in a negative pressure room (if available) under a general anaesthetic with endotracheal intubation.^{8,9} Due to resource constraints we reserve general anaesthetic with endotracheal intubation for longer procedures, such as complicated ERCPs. In addition, we routinely add a further secretion barrier, by placing a clear plastic sheet over the patient's face during the endoscopy, with only a small slit cut over the mouth to allow for passage of the endoscope (Figure 4). In order to reduce patient anxiety, adequate sedation and nasal prong oxygen are mandatory before laying the plastic sheet over the patient's head.

Although to our knowledge there is no documented case of transmission to the endoscopist during colonoscopy, we support the recommendations that during prolonged exposure with potentially virally contaminated faeces, that full PPE as above is also advised.

In these unprecedented times, working in a high-risk and anxiety-provoking environment, team morale is influenced with possible consequent burnout. We are of the view that the simple initiative of making and sourcing protective gear ourselves and proactively attempting to ensure our own safety has empowered our entire endoscopy team (Figure 5). As an endoscopy community, we need to share ideas or suggestions with each other in order to improve patient and staff welfare. Furthermore, we need to be adaptable with directives and guidelines in a fast-changing environment where evidence is still sparse, most importantly adapting to our own environments with best possible practice.

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ORIGINAL

Appendix 2

The CDC has produced a visual guide to PPE use. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/using-ppe>

SEQUENCE FOR PUTTING ON PERSONAL PROTECTIVE EQUIPMENT (PPE)

The type of PPE used will vary based on the level of precautions required, such as standard and contact, droplet or airborne infection isolation precautions. The procedure for putting on and removing PPE should be tailored to the specific type of PPE.

- GOWN**
 - Fully cover torso from neck to knees, arms to end of wrists, and wrap around the back
 - Fasten in back of neck and waist
- MASK OR RESPIRATOR**
 - Secure ties or elastic bands at middle of head and neck
 - Fit flexible band to nose bridge
 - Fit snug to face and below chin
 - Fit-check respirator
- GOGGLES OR FACE SHIELD**
 - Place over face and eyes and adjust to fit
- GLOVES**
 - Extend to cover wrist of isolation gown

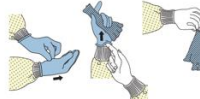



USE SAFE WORK PRACTICES TO PROTECT YOURSELF AND LIMIT THE SPREAD OF CONTAMINATION

- Keep hands away from face
- Limit surfaces touched
- Change gloves when torn or heavily contaminated
- Perform hand hygiene




HOW TO SAFELY REMOVE PERSONAL PROTECTIVE EQUIPMENT (PPE) EXAMPLE 1

There are a variety of ways to safely remove PPE without contaminating your clothing, skin, or mucous membranes with potentially infectious materials. Here is one example. Remove all PPE before exiting the patient room except a respirator, if worn. Remove the respirator after leaving the patient room and closing the door. Remove PPE in the following sequence:

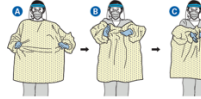


- GLOVES**
 - Outside of gloves are contaminated!
 - If your hands get contaminated during glove removal, immediately wash your hands or use an alcohol-based hand sanitizer
 - Using a gloved hand, grasp the palm area of the other gloved hand and peel off first glove
 - Hold removed glove in gloved hand
 - Slide fingers of ungloved hand under remaining glove at wrist and peel off second glove over first glove
 - Discard gloves in a waste container
- GOGGLES OR FACE SHIELD**
 - Outside of goggles or face shield are contaminated!
 - If your hands get contaminated during goggles or face shield removal, immediately wash your hands or use an alcohol-based hand sanitizer
 - Remove goggles or face shield from the back by lifting head band or ear pieces
 - If the item is reusable, place in designated receptacle for reprocessing. Otherwise, discard in a waste container
- GOWN**
 - Gown front and sleeves are contaminated!
 - If your hands get contaminated during gown removal, immediately wash your hands or use an alcohol-based hand sanitizer
 - Unfasten gown ties, taking care that sleeves don't contact your body when reaching for ties
 - Pull gown away from neck and shoulders, touching inside of gown only
 - Turn gown inside out
 - Fold or roll into a bundle and discard in a waste container
- MASK OR RESPIRATOR**
 - Front of mask/respirator is contaminated — DO NOT TOUCH!
 - If your hands get contaminated during mask/respirator removal, immediately wash your hands or use an alcohol-based hand sanitizer
 - Grasp bottom ties or elastic of the mask/respirator, then the ones at the top, and remove without touching the front
 - Discard in a waste container
- WASH HANDS OR USE AN ALCOHOL-BASED HAND SANITIZER IMMEDIATELY AFTER REMOVING ALL PPE**

PERFORM HAND HYGIENE BETWEEN STEPS IF HANDS BECOME CONTAMINATED AND IMMEDIATELY AFTER REMOVING ALL PPE




HOW TO SAFELY REMOVE PERSONAL PROTECTIVE EQUIPMENT (PPE) EXAMPLE 2

Here is another way to safely remove PPE without contaminating your clothing, skin, or mucous membranes with potentially infectious materials. Remove all PPE before exiting the patient room except a respirator, if worn. Remove the respirator after leaving the patient room and closing the door. Remove PPE in the following sequence:

- GOWN AND GLOVES**
 - Gown front and sleeves and the outside of gloves are contaminated!
 - If your hands get contaminated during gown or glove removal, immediately wash your hands or use an alcohol-based hand sanitizer
 - Grasp the gown in the front and pull away from your body so that the ties break, touching outside of gown only with gloved hands
 - While removing the gown, fold or roll the gown inside-out into a bundle
 - As you are removing the gown, peel off your gloves at the same time, only touching the inside of the gloves and gown with your bare hands. Place the gown and gloves into a waste container
- GOGGLES OR FACE SHIELD**
 - Outside of goggles or face shield are contaminated!
 - If your hands get contaminated during goggles or face shield removal, immediately wash your hands or use an alcohol-based hand sanitizer
 - Remove goggles or face shield from the back by lifting head band and without touching the front of the goggles or face shield
 - If the item is reusable, place in designated receptacle for reprocessing. Otherwise, discard in a waste container
- MASK OR RESPIRATOR**
 - Front of mask/respirator is contaminated — DO NOT TOUCH!
 - If your hands get contaminated during mask/respirator removal, immediately wash your hands or use an alcohol-based hand sanitizer
 - Grasp bottom ties or elastic of the mask/respirator, then the ones at the top, and remove without touching the front
 - Discard in a waste container
- WASH HANDS OR USE AN ALCOHOL-BASED HAND SANITIZER IMMEDIATELY AFTER REMOVING ALL PPE**

PERFORM HAND HYGIENE BETWEEN STEPS IF HANDS BECOME CONTAMINATED AND IMMEDIATELY AFTER REMOVING ALL PPE



Appendix 3: Reuse of Respirators

Background: The nine types of certified particulate respirators that can be used by health care workers include: N95, N99, N100, R95, R99, R100, P95, P99, P100. Respirators are rated “N” if they are not resistant to oil, “R” if they are somewhat resistant to oil, and “P” if they are oil-proof.

It is worth noting that the corona virus is 0.12 microns in diameter, about one tenth the size of an E.coli, and that N95 is designed to filter out 95% of particles with a median size of 0.3 microns in diameter. It follows that a mask rated at N95 or FFP2 is not necessarily sufficient to filter out COVID-19 and they should be used with a face shield. Degradation of the mask with loss of filtering ability will compromise safety.

The following is taken from the CDC but does not represent the whole document which should be reviewed. (Recommended Guidance for Extended Use and Limited Reuse of N95 Filtering Facepiece Respirators in Healthcare Settings. <https://www.cdc.gov/niosh/topics/hcwcontrols/recommendedguidanceextuse.html>)

There is no way of determining the maximum possible number of safe reuses for an N95 respirator as a generic number to be applied in all cases. Safe N95 reuse is affected by a number of variables that impact respirator function and contamination over time (

The CDC recommends discarding masks following aerosol generating procedures and any contaminated with fluids from patients.

Used respirators, which will be reused, should be hung in a designated storage area or in a clean, breathable container such as a paper bag between uses.

To minimize potential cross-contamination, store respirators so that they do not touch each other and the person using the respirator is clearly identified. Storage containers should be disposed of or cleaned regularly.

Clean hands with soap and water or an alcohol-based hand sanitizer before and after touching or adjusting the respirator (if necessary, for comfort or to maintain fit).

Avoid touching the inside of the respirator. If inadvertent contact is made with the inside of the respirator, discard the respirator and perform hand hygiene as described above. Use a pair of clean (non-sterile) gloves when donning a used N95 respirator and performing a user seal check. Discard gloves after the N95 respirator is donned and any adjustments are made to ensure the respirator is sitting comfortably on your face with a good seal.

Improving the safety of Reused Masks.

A number of methods have been recommended to improve the safety of reused masks. The following is taken from SAGES. (SAGES. N95 Mask Re-Use Strategies. <https://www.sages.org/n-95-re-use-instructions/>).

Mask rotation

Acquire a set number of N95 masks, or equivalent, (at least 5 per the CDC), and rotate their use each day, allowing them to dry for long enough that the virus is no longer viable (> 72 hours). Proper storage for this technique requires either hanging the respirators to dry, or keeping them in a clean, breathable container like a paper bag between uses. Make sure the masks do not touch each other, and that you do not share your respirator with other people. A user seal check should be performed before each use.

Hydrogen Peroxide Vaporization

Hydrogen peroxide vapor (HPV) decontamination has been shown in pilot studies to allow multiple cycles of N95 processing with acceptable preservation of function. It is now approved by the FDA as an emergency method for N95 decontamination for healthcare personnel during the COVID-19 pandemic. This method of decontamination can only be used on N95 models that do not contain cellulose, such as the 1860. It is being utilized in industrial facilities such as Battelle (up to 20 cycles) as well as individual hospitals via Sterrad (up to 2 cycles) or Steris equipment (up to 10 cycles).

UV treatment

Proper UV treatment of N95 masks requires specific dosing protocols and full surface area illumination to ensure proper inactivation of viral particles with minimal mask degradation. Due to the precision required, home UV light use is not recommended. This method of decontamination has been implemented by some hospital systems in the United States.

Moist Heat

Moist heat (heating at 60-70°C and 80-85% relative humidity) has been shown to be effective for flu viruses, but there is limited data on the temperature, humidity, and time required to completely inactivate SARS-COV-2 viral particles. Moreover, the parameters required to kill the virus may adversely affect filtration efficacy of the mask. Due to the dearth of specific data on a protocol to achieve both aims, this method is not currently recommended.

Dry Heat

Dry heating of the mask at 70°C for 30 minutes has been suggested as a method of decontamination which can adequately kill virus and preserve the filter integrity for re-use. Recent tests at the NIH utilizing SARS-CoV-2 specifically indicated that this method can be used for two cycles to kill the virus without compromising fit. Research efforts are ongoing to determine optimal parameters (temperature and duration), and this is not yet recommended by the CDC