LUI Rashid (Orcid ID: 0000-0003-1277-9595)
Wong Sunny (Orcid ID: 0000-0002-3354-9310)

Overview of guidance for endoscopy during the coronavirus disease 2019 (COVID-19) pandemic

Rashid N Lui[1,2], Sunny H Wong[1,2], Sergio A Sánchez-Luna[3], Gianluca Pellino[4,5], Steven Bollipo[6], Mei-Yin Wong[1,7], Philip WY Chiu[1,7], Joseph JY Sung[1-2]

1 Institute of Digestive Disease, The Chinese University of Hong Kong, Hong Kong, China
2 Department of Medicine and Therapeutics, Faculty of Medicine, The Chinese University of Hong Kong
3 Division of Gastroenterology and Hepatology, The University of New Mexico School of Medicine, Albuquerque, New Mexico, United States
4 Department of Advanced Medical and Surgical Sciences, Università degli Studi della Campania "Luigi Vanvitelli", Naples, Italy
5 Colon and Rectal Surgery Unit, Vall d'Hebron University Hospital, Barcelona, Spain
6 Department of Gastroenterology, John Hunter Hospital, New South Wales, Australia
7 Department of Surgery, Faculty of Medicine, The Chinese University of Hong Kong

Corresponding author:
Professor Joseph Sung MD, PhD
Institute of Digestive Disease
The Chinese University of Hong Kong
Prince of Wales Hospital
Shatin, Hong Kong
jjysung@cuhk.edu.hk
(852) 3505 3174

The authors declare no potential conflicts of interest

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/jgh.15053

This article is protected by copyright. All rights reserved.

Abbreviations

COVID-19 coronavirus disease 2019

WHO World Health Organization

AGP Aerosol generating procedure

HCP Healthcare personnel

PPE Personal protective equipment

SARS-CoV-2 Severe acute respiratory syndrome coronavirus 2

SARS Severe Acute Respiratory Syndrome

MERS Middle East Respiratory Syndrome

ACE2 Angiotensin converting enzyme 2

CDC Centers for Disease Control and Prevention

BSG The British Society of Gastroenterology

JAG Joint Advisory Group

RT-PCR Reverse transcription polymerase chain reaction

AAMI Association for the Advancement of Medical Instrumentation

UK United Kingdom

RNA Ribonucleic acid

WEO World Endoscopy Organization

GESA Gastroenterological Society of Australia

ESGE European Society of Gastrointestinal Endoscopy

ESGENA European Society of Gastroenterology and Endoscopy Nurses and Associates

GI Gastrointestinal

CAG Canadian Association of Gastroenterology

Accepted Article

This article is protected by copyright. All rights reserved.

Abstract

From its beginning in December 2019, the COVID-19 outbreak has spread globally from Wuhan and is now declared a pandemic by the World Health Organization (WHO). The sheer scale and severity of this pandemic is unprecedented in the modern era. Though primarily a respiratory tract infection transmitted by direct contact and droplets, during aerosol generating procedures (AGPs) there is a possibility of airborne transmission. In addition, emerging evidence suggests possible fecal-oral spread of the virus. Clinical departments that perform endoscopy are faced with daunting challenges during this pandemic. To date, multiple position statements and guidelines have been issued by various professional organizations to recommend practices in endoscopic procedures. This article aims to summarize and discuss available evidence for these practices, to provide guidance for endoscopy to enhance patient safety, avoid nosocomial outbreaks, protect healthcare personnel and ensure rational use of personal protective equipment (PPE). Responses adapted to national recommendations, local infection control guidelines and tailored to the availability of medical resources are imminently needed to fight the COVID-19 pandemic.

Introduction

A novel coronavirus outbreak began in Wuhan in December 2019 which rapidly spread throughout the country and beyond [1]. Since then, the outbreak has evolved rapidly with COVID-19 being declared a global pandemic by the World Health Organization (WHO) in March 2020 [2]. As of 23 March 2020, it has infected over 350,000 people worldwide [3] and caused more than 12,000 deaths [4]. The sheer scale, severity and rapidity of spread of this pandemic is unprecedented.

The clinical characteristics of COVID-19 have been described elsewhere [5–8]. Gastrointestinal manifestations are present but seem to be less common when compared with Severe Acute Respiratory Syndrome (SARS) or Middle East Respiratory Syndrome (MERS) [9]. Early reports from Wuhan indicated that around 10% of cases presented with diarrhea and nausea, 1 to 2 days before the onset of fever and dyspnea [8]. Potential cases of COVID-19 may be missed if only respiratory symptoms alone are screened. It is widely accepted that COVID-19 is mainly spread via droplets and contact, but there is evidence that airborne spread is possible during aerosol generating procedures (AGPs). In addition, emerging evidence suggests that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes COVID-19 and formerly known as the 2019 novel coronavirus (2019-nCoV), can be detected in the feces of patients, leading to the distinct possibility of transmission by fecal-oral route [10–13]. This affinity may be due to the abundant expression of ACE2 protein, a receptor for SARS-CoV-2 required for cell entry [14], in the epithelial layer of the gastrointestinal tract[11]. Further complicating

This article is protected by copyright. All rights reserved.

matters are models that suggest substantial spread by undocumented infections [15] reports of asymptomatic carriers unknowingly spreading the infection to close contacts [16,17] and findings that suggest the detectable viral loads were similar in symptomatic and asymptomatic patients [18].

Clinical departments performing endoscopy are faced with great challenges during this pandemic. 3.8% of confirmed cases from China were health care personnel (HCP) with deaths reported [19]. In Italy the situation may be even more dire with HCP comprising 8.3% of the country's total number of cases [20]. Endoscopy is likely a high-risk procedure as pulmonary and gastric secretions, as well as fecal material may contain large viral loads. Infection prevention and control (IPC) measures must be implemented to enhance patient safety, avoid nosocomial outbreaks, protect healthcare personnel and ensure rational use of limited personal protective equipment (PPE). Multiple endoscopy societies and expert groups have offered recommendations and position statements for endoscopy during the COVID-19 pandemic[21–30]. Their guidance is summarized and discussed below (Table 1 and Figure 1).

Measures

1. General

1.1 Endoscopy unit setup

Planning and revision of workflows is necessary for patient and staff safety and to implement appropriate infection prevention and control measures. The principle of "three zones and two passages" [31] should be followed: a contaminated zone, a potentially contaminated zone and a clean zone should be clearly demarcated, with adequate buffer areas in between. Workflows to allow designated one-way passages for the transportation of used/contaminated equipment (such as endoscopes) are needed to avoid cross-contamination with clean/disinfected equipment. Endoscopy unit layouts need to be adjusted to separate gown-up and gown-down areas to prevent cross-contamination. Lidded refuse bins are necessary for the disposal of used PPE.

A designated triage station with staff wearing appropriate levels of PPE should be set up. Regular updates of countries or regions designated as high risk is needed. Separation in space and/or time between suspected and confirmed COVID-19 patients and other patients should be arranged [32]. This will include workflows on the use of negative pressure/single rooms. Designated toileting facilities should also be offered for suspected or confirmed cases in line with CDC suggestions [33] and reminded of hygiene measures such as closing the lid before flushing to reduce bioaerosol formation [34]. Patient cohorting measures should be set up for recovery rooms.

This article is protected by copyright. All rights reserved.

1.2 Dedicated clinical teams

Staff cohorting with dedicated teams in charge of high-risk patients or equipment should be encouraged if there are sufficient manpower available [32]. A rota system with pre-defined work hours should be considered.

1.3 Inventory

Stocktaking of current levels of PPE and anticipated supply and usage rates are essential to plan ahead on endoscopy service provision [24]. It is essential that appropriate PPE supplies are available for the protection of all HCP (Figure 2).

1.4 Postpone non-urgent cases

Non-urgent, elective cases should be deferred. There is a broad consensus with this policy and it has been advocated by various groups [21–30]. All cases except endoscopic emergencies such as gastrointestinal bleeding, acute cholangitis, biliary pancreatitis, foreign body retrieval and selected cases of obstructive jaundice etc should be postponed. Potential or confirmed cancer cases may be particularly difficult to be re-scheduled and should be reviewed on a case-by-case basis. The British Society of Gastroenterology (BSG)/Joint Advisory Group (JAG) guidance provides a comprehensive list of prioritized procedures [22]. The European Society of Gastrointestinal Endoscopy (ESGE)/European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA) advocates an evaluation of gastrointestinal disease-related morbidity/mortality for elective cases [29]. Prioritization can decrease the patient load of hospitals and reduce the inherent risk of cross-infection, minimize potential exposure to healthcare personnel, and free up manpower for urgent services. Due to enhanced infection control measures that include a thorough assessment of symptoms and travel history beforehand, the time needed to properly don and duff PPE, the need for environmental decontamination and the anticipated manpower shortages due to illness, quarantine, self-isolation or redeployment, the throughput of endoscopy units will inevitably be reduced during the COVID-19 outbreak. Also, PPE stocks worldwide are expected to be limited for the foreseeable future due to supply chain disruptions [35] and postponement of elective cases would be able to reduce its usage rate to conserve precious medical resources. It is advisable that units keep lists of patients that should be given priority once access to regular endoscopic services are resumed [27].

This article is protected by copyright. All rights reserved.

2. Identification of potential and confirmed COVID-19 patients

2.1 Screening

In general, screening of patients for respiratory symptoms such as cough, runny nose and/or shortness of breath together with assessment of FTOCC (fever, travel, occupation, contact and clustering) is considered mandatory prior to entry into the endoscopy unit. Evidence suggests that gastrointestinal symptoms such as nausea, vomiting and diarrhea should not be overlooked as they may be part of the prodrome, occur simultaneously with the more commonly present respiratory tract symptoms and fever, and in some cases be the only symptoms present [36]. It has been suggested that anosmia is another overlooked symptom [37]. If screening result is positive, patient workflows in line with local IPC measures must be in place to direct the patient away from the endoscopy unit to seek prompt medical attention at designated clinics, for quarantine or to self-isolate depending on the clinical scenario. This triage process should be repeatedly adjusted based on the rapidly evolving local and global epidemiology of COVID-19 [28].

2.2 Lab abnormalities in COVID-19

If there is access to laboratory results, proposed hints to COVID-19 infection include lymphopenia, elevated lactate dehydrogenase and ferritin, and liver enzyme abnormalities [38]. However, these findings are non-specific, and their usefulness is limited to making clinical decisions for borderline cases.

2.3 Others

In China, screening computed tomography (CT) of the chest is routinely performed prior to endoscopy [39]. Practice from Wuhan which have been supported by the World Endoscopy Organization (WEO) [21] suggests that this is a fast, accurate and effective screening tool as CT findings may precede a positive SARS-CoV-2 test [40,41]. This strategy may be difficult to generalize to other healthcare systems due to issues relating to cost and accessibility. Some also advocate screening with IgM/IgG for COVID-19 [39]. In Hong Kong, reverse transcription polymerase chain reaction (RT-PCR) of nasopharynx or oropharynx for COVID-19 testing prior to endoscopy in selected cases is used but the effectiveness of this strategy is unproven. Point-of-care testing for COVID-19 may become available in the near future and allow more accurate risk stratification [24].

Accepted Article

This article is protected by copyright. All rights reserved.

2.4 Risk of infectivity in COVID-19 recovered patients

With more confirmed COVID-19 cases recovering, a new challenge arising would be the timing of endoscopy for this patient group. Studies have shown that the median duration of viral shedding was 20 days and can persist up to 37 days [42]. A small series of four patients with COVID-19 who met criteria for hospital discharge or discontinuation of quarantine in China (absence of clinical symptoms, radiological abnormalities and 2 negative RT-PCR test results) had positive RT-PCR test results 5 to 13 days later, suggesting that a proportion of recovered patients may still be shedding virus [43]. In addition, persistent SARS-CoV-2 RNA was detected in fecal samples for a mean of 27.9 days (with one patient testing positive for up to 47 days) [44]. Unless in emergent cases where the endoscopy should proceed regardless, patients should be presumed to be still infectious for at least 2 weeks after convalescence. Stool testing for SARS-CoV-2 virus could also play a role in risk stratification as well.

3. Pre-endoscopy

All patients who are indicated for urgent endoscopy will be required to wear surgical masks, perform hand hygiene with alcohol-based hand rub and/or wear gloves. Patients should be spaced apart to avoid close contact in the endoscopy unit with a distance of at least 1 to 1.8 meters [24,25,35]. Close communication with wards should be encouraged to restrict the number of patients in the waiting areas at any given time to avoid overcrowding and minimize waiting times. A strict no visiting policy (except on compassionate grounds) should be enforced to minimize the risk of cross-infection. If this is allowed in exceptional circumstances, the same risk assessment for patients should be applied. Suspected or confirmed cases should be separated from other patients as discussed previously.

4. Endoscopy

Risk stratification is essential to determine the location where the endoscopy is to be done and the level of PPE protection required. Ideally this should be performed before the patient is sent to the endoscopy unit to minimize unnecessary transferrals. We have dichotomized into high-risk and non-high-risk groups to simplify the decision-making process (Figure 3).

4.1 High-risk patients and procedures

A. If a patient has positive screening, suspected or confirmed COVID-19, the endoscopy should be performed in negative pressure facilities where available with healthcare personnel wearing full PPE with N95 respirators or equivalent, and water-resistant gowns (AAMI level 3)(Figure 4).

This article is protected by copyright. All rights reserved.

B. Bronchoscopy is an established AGP [45] and should be performed in negative pressure facilities where available with healthcare personnel wearing full PPE with N95 respirators or equivalent, and water-resistant gowns (AAMI level 3).

C. The risk of other endoscopic procedures such as esophagogastroduodenoscopy (OGD), endoscopic retrograde cholangio-pancreatography (ERCP), endoscopic ultrasound (EUS), flexible laryngoscopy [46] and colonoscopy (CLN) have not been well studied. The British Society of Gastroenterology believes that upper GI endoscopy of all kinds must be regarded as an aerosol prone procedure. The Safe Airway Society of Australia and New Zealand classifies gastroscopy as a procedure vulnerable to aerosol generation [47]. This sentiment is echoed in a handbook based on clinical experience from China [31]. Objectively, during upper endoscopy the patient may aspirate, cough, retch and require oral suction which carries a risk for aerosolization. Viable virus have been detected in aerosols up to 3 hours after AGPs [48]. The Wuhan practice (supported by the World Endoscopy Organization) which is in line with BSG, Milan group, the Canadian Association of Gastroenterology and the Safe Airway Society advise that such procedures be performed with healthcare personnel wearing full PPE with N95 respirators or equivalent, and water-resistant gowns. Patient discomfort and retching may be minimized by adequate sedation.

4.2 Non-high-risk patients and procedures

A. A patient who is not suspected to have COVID-19 and is clinically indicated for colonoscopy can be considered as non-high risk. There is no evidence available to suggest that colonoscopy is an aerosol prone procedure. Additionally, a case report of health care workers exposed to an AGP for a COVID-19 patient showed that surgical masks, hand hygiene, and other standard procedures were adequate [49]. Even so, as the virus is known to be shed in stools the risk of exposure to staff and cross-contamination should be seriously considered. As such, all non-urgent colonoscopies should be deferred. If clinically indicated to proceed, colonoscopy should be performed with healthcare personnel wearing full PPE, preferably with N95 respirators and water-resistant gowns.

4.3 Personal protective equipment

Full PPE includes hair net, face shield/goggles, surgical masks/N95 respirators or equivalent (dependent on the risk assessment), gown and gloves. Some authors advocate double gloving as well [23,28,29]. In face of limited availability of respirators, ESGE/ESGENA recommends that extended use for up to 4 hours is acceptable [29]. The CDC has also issued recommendations allowing for extended use and limited re-use of respirators [50]. We believe that re-use of N95 respirators should be avoided as these may be contaminated and pose a risk to healthcare personnel and be only considered as a measure of last resort.

This article is protected by copyright. All rights reserved.

4.4 Endoscopy team member selection

Endoscopic procedures should be performed by senior/independent endoscopists with on-hands training or in-person educational sessions suspended [26]. Nursing and other supporting staff present in the room should also be limited to the absolute minimum required for patient care and safety [45]. This can reduce healthcare personnel exposure to COVID-19. Administrative controls should also be in place to minimize the need for the clinical team performing endoscopy to leave the endoscopy room and come into contact with other staff in the endoscopy unit. Communication with other staff can be facilitated by radio devices. Other staff in the clean area can complete the procedure report to avoid contamination and conserve PPE [24].

5. Post-endoscopy

5.1 Environmental decontamination

Viable SARS-CoV-2 virus can be found on plastic and stainless steel surfaces for up to 3 days [48]. Environmental decontamination is essential to reduce the risk of fomite transmission. Disinfection measures using alcohol- or chlorine- based solutions are reported to be effective [51]. This should be performed after each case especially for surfaces frequently in contact with patients such as bed rails, bedside tables, furniture and the floor [23]. After the end of each list, or if gross contamination has occurred, an in-depth cleaning process followed by disinfection is needed.

5.2 Scope disinfection

Scopes and accessories should be reprocessed per existing guidelines [52,53]. The majority of gastrointestinal endoscopes are semi-critical devices that require cleaning and disinfection with agents that have bactericidal, fungicidal, mycobactericidal, and viricidal activity [53]. Evidence from a prior study after the SARS outbreak have shown that SARS-CoV-1 was readily inactivated by all disinfectants tested (four varieties of hand rubs, three surface disinfectants and a glutaraldehyde-based medical instrument disinfectant [54], suggesting that current reprocessing protocols and high-level disinfectants are adequate [55]. Further precautions should be taken when reprocessing equipment used in a confirmed COVID-19 case such as the use of N95 or equivalent respirators [29]. The reuse of any disposable endoscopic device is strongly discouraged [29]. Staff in charge should attend training sessions to ensure strict adherence to such protocols [23].

This article is protected by copyright. All rights reserved.

5.3 Waste management

Contaminated waste and endoscopic devices from high-risk patients, or with suspected or confirmed COVID-19 should be disposed of using the specific local regulations related to high-risk waste [29].

5.4 Recovery

Designated recovery rooms should be set up to separate suspected and/or confirmed COVID-19 patients, and other patients to minimize the risk of cross-infection.

For patient management, early use of reversal agents after sedatives in suspected or confirmed COVID-19 should be considered to avoid respiratory failure and decreased consciousness to avoid the need for high flow oxygen therapy and resuscitation, which are known AGPs [32].

Staff should be trained and drilled on updated cardiopulmonary resuscitation (CPR) care pathways for suspected or confirmed COVID-19 cases. Though this is also beyond the scope of this article, the guidance promulgated by the Resuscitation Council UK include: readily available equipment to protect staff during resuscitation attempts, full AGP PPE should be worn by members of the resuscitation team, restrict the number of staff, do not listen or feel for breathing by placing ears and cheeks close to the patient's mouth, start compression-only CPR and avoid mouth-to-mouth ventilation, with early airway interventions to be performed only by experienced staff [56], which in most endoscopy units would mean waiting for anesthetist support.

5.5 Follow-up

Consider contacting patients, preferably by phone at 7 and 14 days to ask about any new diagnosis, or development of COVID-19 symptoms [23,25,29]. If present, pathways for referral of the patient to seek medical attention, together with contact tracing of possible staff who have been exposed is required according to hospital infection prevention and control policies. Telehealth for follow-up may be helpful if the expertise and infrastructure is available.

6. Staff measures

6.1 General

All staff should be engaging infection control measures such as practicing hand hygiene and wearing facemasks [57] in healthcare facilities. Hair should be kept short and facial hair clean-

This article is protected by copyright. All rights reserved.

shaven. Social distancing and minimizing travel and clustering has been suggested. Working clothes should be used where available and changed before leaving hospital/endoscopy unit premises. Taking a shower before leaving is likely a good practice as well. Separate pairs of shoes may also be considered. This may also address concerns relating to the risk of family transmission of disease. In staff lounges and canteens, only sitting in one direction is allowed to minimize the risk from face-to-face transmission [24].

Social distancing is important. All non-essential gatherings, including seminars and conferences should be cancelled or switched to virtual meetings.

6.2 PPE training

All endoscopy staff must receive adequate education and enhanced training relating to the use of PPE to minimize protocol deviations as self-contamination during doffing is frequently encountered [58]. Many resources are readily available from various institutions and the web. Instructions for the correct techniques in handling and disposing PPE should also be given.

6.3 Respirator fit test

N95 respirators and equivalent require a personalized fit to achieve a tight seal to achieve protection. Staff who would potentially come into contact with potential or confirmed COVID-19 patients should have a fit test done as soon as possible if this was not performed previously. Significant changes in facial contour or fluctuations of body weight should also prompt a repeat fit test [59].

6.4 Communication

Regular updates with hospital administrators, the infection control team and amongst endoscopy staff in the form of forums, departmental meetings, teleconferences, communication kits, daily emails [24] and formal chatgroups are important to ensure all staff obtain up-to-date information to reduce anxiety and fear amongst HCP and to tackle misinformation from sources such as social media [60] .

6.5 Well-being

The physical and psychological well-being of HCP should not be overlooked. Staff are exposed to hazards that include pathogen exposure, long working hours, psychological distress, fatigue, burnout, stigma, and physical and psychological violence. [61]. In some cases, if staff are exposed to suspected cases and require quarantine, negative psychological effects may include post-traumatic stress symptoms, confusion, and anger. In situations where quarantine is deemed

This article is protected by copyright. All rights reserved.

necessary, the duration should be for no longer than required, with clear rationale and information for quarantine given, and to ensure sufficient supplies are provided [62]. In addition, usual practices such as regular exercise, meditation, intake of fruits, constant communication with friends and family members, adequate rest and sleep are essential to maintain well-being. Finally, the social distancing recommended during this pandemic can generate anxiety and frustration in many people and thus emotional and psychological tools to overcome these afflictive emotions may be of benefit [63].

Conclusion

It is imperative that all endoscopy units establish clear plans and standard operating procedures to ensure that proper safeguards are in place to protect patients and healthcare personnel alike. Only through mutual support and solidarity can we overcome the COVID-19 pandemic together.

References

1 Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y *et al.* Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia. *N Engl J Med* 2020; 19–20.

2 https://www.who.int/docs/default-source/coronaviruse/transcripts/who-audio-emergencies-coronavirus-press-conference-full-and-final-11mar2020.pdf?sfvrsn=cb432bb3_2 (accessed 20 March 2020).

3 Coronavirus COVID-19 Global Cases by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. https://www.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6 (accessed 23 March 2020).

4 Coronavirus disease (COVID-2019) situation reports. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/ (accessed 23 March 2020).

5 Guan W-J, Ni Z-Y, Hu Y, Liang W-H, Ou C-Q, He J-X *et al.* Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med* 2020; : 1–13.

6 Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y *et al.* Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020; **395**: 497–506.

7 Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y *et al.* Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a

This article is protected by copyright. All rights reserved.

descriptive study. *Lancet* 2020; **395**: 507–513.

8 Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J *et al.* Clinical Characteristics of 138 Hospitalized Patients with 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA* 2020; 1–9.

9 Wong S, Lui R, Sung J. COVID-19 and the Digestive System. *J Gastroenterol Hepatol* 2020.

10 Gu J, Han B, Wang J. COVID-19: Gastrointestinal manifestations and potential fecal-oral transmission. *Gastroenterology* 2020. doi:10.1053/j.gastro.2020.02.054.

11 Xiao F, Tang M, Zheng X, Liu Y, Li X, Shan H. Evidence for gastrointestinal infection of SARS-CoV-2. *Gastroenterology* 2020. doi:10.1053/j.gastro.2020.02.055.

12 Wang W, Xu Y, Gao R, Lu R, Han K, Wu G *et al.* Detection of SARS-CoV-2 in Different Types of Clinical Specimens. *JAMA* 2020; 19–20.

13 Stool Screening Helps to Uncover Asymptomatic Cases of COVID-19 Patients. https://cuhkintouch.cpr.cuhk.edu.hk/2020/03/2094/.

14 Hoffmann M, Kleine-Weber H, Schroeder S, Krüger N, Herrler T, Erichsen S *et al.* SARS-CoV-2 Cell Entry Depends on ACE2 and TMPRSS2 and Is Blocked by a Clinically Proven Protease Inhibitor. *Cell* 2020. doi:10.1016/j.cell.2020.02.052.

15 Li R, Pei S, Chen B, Song Y, Zhang T, Yang W *et al.* Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV2). *Science (80-)* 2020; eabb3221.

16 Bai Y, Yao L, Wei T, Tian F, Jin D-Y, Chen L *et al.* Presumed Asymptomatic Carrier Transmission of COVID-19. *JAMA* 2020. doi:10.1001/jama.2020.2565.

17 Rothe C, Schunk M, Sothmann P, Bretzel G, Froeschl G, Wallrauch C *et al.* Transmission of 2019-nCoV Infection from an Asymptomatic Contact in Germany. *N Engl J Med* 2020; 2019–2020.

18 Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z *et al.* SARS-CoV-2 Viral Load in Upper Respiratory Specimens of Infected Patients. *N Engl J Med* 2020; **382**: 1177–1179.

19 Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases

Accepted Article

This article is protected by copyright. All rights reserved.

From the Chinese Center for Disease Control and Prevention. *JAMA* 2020; **2019**: 3–6.

20 https://abcnews.go.com/International/italy-coronavirus-death-toll-surpasses-china-task-force/story?id=69704673 (accessed 21 March 2020).

21 Zhang, Yafei; Zhang, Xiaodan; Liu, L; Wang, Hongling; Zhao Q. Suggestions of Infection Prevention and Control in Digestive Endoscopy During Current 2019-nCoV Pneumonia Outbreak in Wuhan, Hubei Province, China.

22 Endoscopy activity and COVID-19: BSG and JAG guidance. https://www.bsg.org.uk/covid-19-advice/endoscopy-activity-and-covid-19-bsg-and-jag-guidance/ (accessed 22 March 2020).

23 Repici A, Maselli R, Colombo M, Gabbiadini R, Spadaccini M, Anderloni A *et al.* Coronavirus (COVID-19) outbreak: what the department of endoscopy should know. *Gastrointest Endosc* 2020. doi:10.1016/j.gie.2020.03.019.

24 Soetikno R, Teoh AYB, Kaltenbach T, Lau JYW, Asokkumar R, Cabral-prodigalidad P *et al*. Considerations in performing endoscopy during the COVID-19 pandemic. *Gastrointest Endosc* 2020.

25 Joint GI Society Message on COVID-19. https://gi.org/2020/03/15/joint-gi-society-message-on-covid-19/ (accessed 21 March 2020).

26 SAGES Recommendations regarding surgical response to COVID-19 Crisis. https://www.sages.org/recommendations-surgical-response-covid-19/ (accessed 21 March 2020).

27 GESA statement on Considerations for Australian Endoscopy Units During the COVID-19 Pandemic 2020.

28 COVID-19: Advice from the Canadian Association of Gastroenterology for Endoscopy Facilities, as of March 16, 2020.

29 ESGE and ESGENA Position Statement on gastrointestinal endoscopy and the COVID-19 pandemic 2020.

30 Malaysian Society of Gastroenterology & Hepatology Alert on COVID-19.

31 *Handbook of COVID-19 Prevention and Treatment.* The First Affiliated Hospital, Zhejiang University School of Medicine, China.

This article is protected by copyright. All rights reserved.

32 COVID-19: Guidance for infection prevention and control in healthcare settings. Version 1.0. Public Health England.

33 What to do if you are sick with coronavirus disease 2019 (COVID-19). https://www.cdc.gov/coronavirus/2019-ncov/downloads/sick-with-2019-nCoV-fact-sheet.pdf.

34 Knowlton SD, Boles CL, Perencevich EN, Diekema DJ, Nonnenmann MW, CDC Epicenters Program. Bioaerosol concentrations generated from toilet flushing in a hospital-based patient care setting. *Antimicrob Resist Infect Control* 2018; **7**: 16.

35 World Health Organization (WHO). Rational use of personal protective equipment for coronavirus disease 2019 (COVID-19). *WHO* 2020; **2019**: 1–7.

36 Pan L, Mu M, Yang P, Sun Y, Wang R, Yan J *et al*. Clinical characteristics of COVID-19 patients with digestive symptoms in Hubei, China: a descriptive, cross-sectional, multicenter study. *Am J Gastroenterol*.

37 Loss of sense of smell as marker of COVID-19 infection. https://www.entuk.org/loss-sense-smell-marker-covid-19-infection.

38 Coronavirus disease 2019 (COVID-19). https://www.uptodate.com/contents/coronavirus-disease-2019-covid-19 (accessed 20 March 2020).

39 Mao R, Liang J, Shen J, Ghosh S, Zhu L-R, Yang H *et al.* Implications of COVID-19 for patients with pre-existing digestive diseases. *Lancet Gastroenterol Hepatol* 2020; **0**: 2019–2021.

40 Shi H, Han X, Jiang N, Cao Y, Alwalid O, Gu J *et al.* Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study. *Lancet Infect Dis* 2020; **3099**: 1–10.

41 Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W *et al.* Correlation of Chest CT and RT-PCR Testing in Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. *Radiology* 2020; 200642.

42 Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z *et al.* Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan , China : a retrospective cohort study. *Lancet* 2020; **6736**: 1–9.

43 Lan L, Xu D, Ye G, Xia C, Wang S, Li Y *et al.* Positive RT-PCR Test Results in Patients

Accepted Article

This article is protected by copyright. All rights reserved.

Recovered From COVID-19. *JAMA* 2020; 2–3.

44 Wu Y, Guo C, Tang L, Hong Z, Zhou J, Dong X *et al.* Prolonged presence of SARS-CoV-2 viral RNA in faecal samples. *Lancet Gastroenterol Hepatol* 2020. doi:10.1016/S2468-1253(20)30083-2.

45 World Health Organization (WHO). Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected interim guidance. *WHO* 2020.

46 Chan JYK, Wong EWY, Lam W. Practical Aspects of Otolaryngologic Clinical Services During the 2019 Novel Coronavirus Epidemic. *JAMA Otolaryngol Neck Surg* 2020. doi:10.1001/jamaoto.2020.0488.

47 Consensus statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID-19 adult patient group. *Med J Aust* 2020.

48 van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN *et al.* Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *N Engl J Med* 2020; NEJMc2004973.

49 Ng K, Poon BH, Kiat Puar TH, Shan Quah JL, Loh WJ, Wong YJ *et al.* COVID-19 and the Risk to Health Care Workers: A Case Report. *Ann Intern Med* 2020. doi:10.7326/L20-0175.

50 CDC 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.

51 Ong SWX, Tan YK, Chia PY, Lee TH, Ng OT, Wong MSY *et al.* Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. *JAMA* 2020; 3–5.

52 ASGE Quality Assurance in Endoscopy Committee, Calderwood AH, Day LW, Muthusamy VR, Collins J, Hambrick RD *et al.* ASGE guideline for infection control during GI endoscopy. *Gastrointest Endosc* 2018; **87**: 1167–1179.

53 Beilenhoff U, Biering H, Blum R, Brljak J, Cimbro M, Dumonceau J-M *et al.* Reprocessing of flexible endoscopes and endoscopic accessories used in gastrointestinal endoscopy: Position Statement of the European Society of Gastrointestinal Endoscopy (ESGE) and European Society of Gastroenterology Nurses

Accepted Article

This article is protected by copyright. All rights reserved.

and Associates (ESGENA). *Endoscopy* 2018; **50**: 1205–1234.

54 Rabenau HF, Kampf G, Cinatl J, Doerr HW. Efficacy of various disinfectants against SARS coronavirus. *J Hosp Infect* 2005; **61**: 107–11.

55 Nelson DB, Muscarella LF. Current issues in endoscope reprocessing and infection control during gastrointestinal endoscopy. *World J Gastroenterol* 2006; **12**: 3953–64.

56 Resuscitation Council UK Statement on COVID-19 in relation to CPR and resuscitation in first aid and community settings. https://www.resus.org.uk/media/statements/resuscitation-council-uk-statements-on-covid-19-coronavirus-cpr-and-resuscitation/covid-community/.

57 Jefferson T, Del Mar CB, Dooley L, Ferroni E, Al-Ansary LA, Bawazeer GA *et al.* Physical interventions to interrupt or reduce the spread of respiratory viruses. *Cochrane Database Syst Rev* 2011. doi:10.1002/14651858.CD006207.pub4.

58 Suen LKP, Guo YP, Tong DWK, Leung PHM, Lung D, Ng MSP *et al.* Self-contamination during doffing of personal protective equipment by healthcare workers to prevent Ebola transmission. *Antimicrob Resist Infect Control* 2018; **7**: 157.

59 Zhuang Z, Bergman M, Brochu E, Palmiero A, Niezgoda G, He X *et al.* Temporal changes in filtering-facepiece respirator fit. *J Occup Environ Hyg* 2016; **13**: 265–274.

60 Zarocostas J. How to fight an infodemic. *Lancet* 2020; **395**: 676.

61 Coronavirus Disease (COVID-19) Outbreak: Rights, Roles and Responsibilities of Health Workers, Including Key Considerations for Occupational Safety and Health. World Health Organization. https://www.who.int/docs/default-source/coronaviruse/who-rights-roles-respon-hw-covid-19.pdf?sfvrsn=bcabd401_0 (accessed 22 March 2020).

62 Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N *et al.* The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 2020; **395**: 912–920.

63 https://tryhealthyminds.org/ (accessed 23 March 2020).

Accepted Article

This article is protected by copyright. All rights reserved.

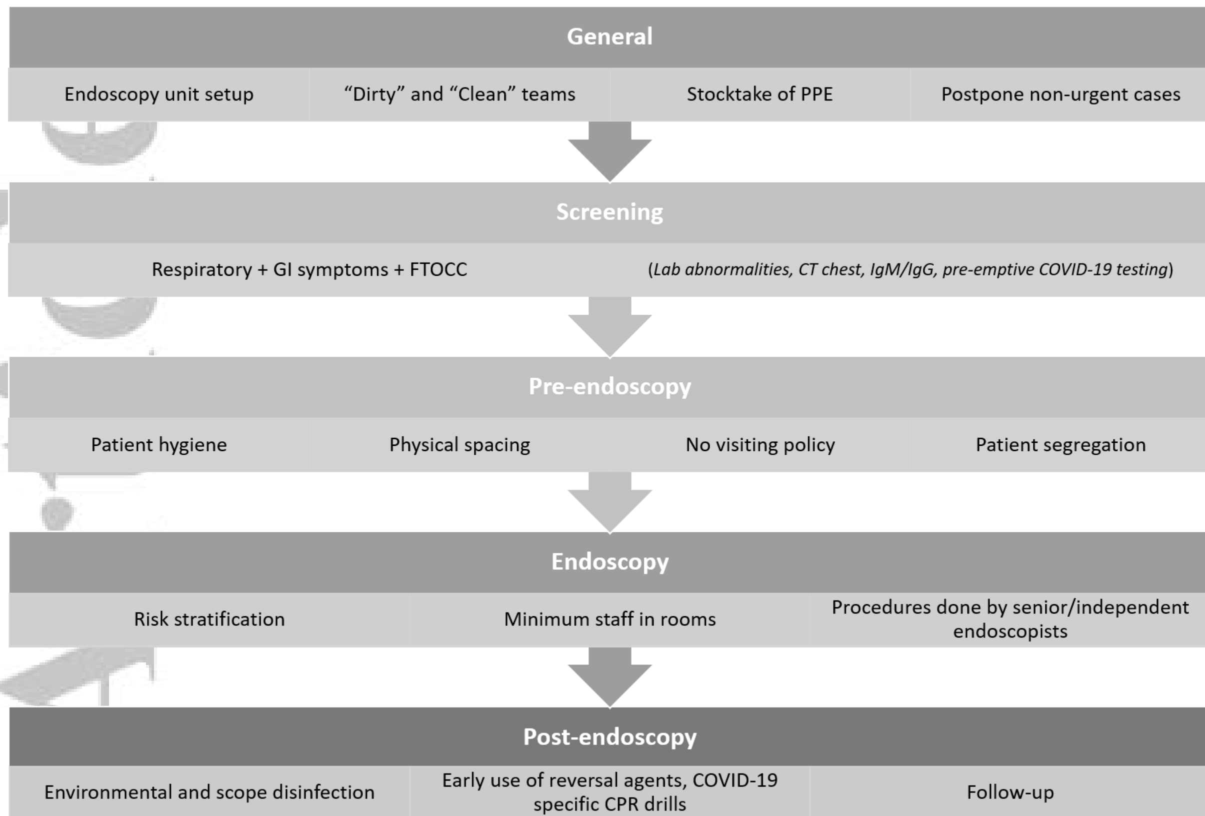

Figure 1. Overview of measures

Accepted

This article is protected by copyright. All rights reserved.

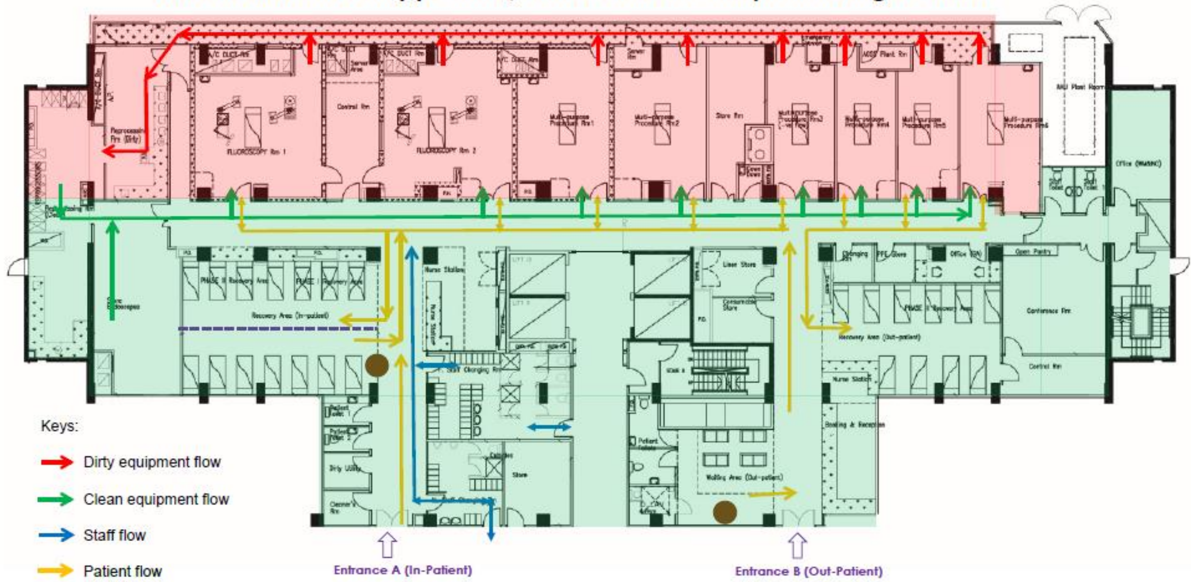

Figure 2. Proposed workflow of endoscopy unit

Accepted Article

This article is protected by copyright. All rights reserved.

Non-high-risk	High-risk	High-risk
Colonoscopy and other endoscopies	Upper GI endoscopy	Suspected or confirmed COVID-19 cases Bronchoscopy
N95 or equivalent (preferably) Water-resistant gowns	N95 or equivalent Water-resistant gowns	N95 or equivalent Water-resistant gowns (AAMI level 3) Negative pressure rooms where available

Figure 3. Risk stratification

Accepted

This article is protected by copyright. All rights reserved.

Accepted Article

Figure 4. Personal protective equipment with N95 or equivalent

This article is protected by copyright. All rights reserved.

Table 1. Summary of guidance

	Practice in Hong Kong	Wuhan (WEO)(Zhang *et al.* [21])	Australia (GESA [27])	United Kingdom (BSG/ JAG [22])	Europe (ESGE/ESGENA [29])	Milan (Repici *et al.* [23])	US Joint GI Society Message [25]	Canadian (CAG [28])
Postpone non-urgent cases	Yes	Yes	Yes	Yes	Yes	Not specified	Yes	Yes
Definition of urgent/non-urgent cases	UGIB, acute cholangitis, foreign body, obstructive symptoms, cancer patients case-by-case	Only emergency cases in outbreak areas: Acute GIB, foreign bodies and acute suppurative cholangitis	Urgent and emergency	1. Needs to continue 2. Defer until further notice 3. Needs discussion	Assess GI disease-related morbidity and mortality	Not specified	Urgent and non-urgent/perform, non-urgent/postpone	Each institution will have to decide on criteria for "essential" GI procedures If resources too low then severely restriction to only GI bleeding, obstruction of esophagus by food bolus or foreign body, and ascending cholangitis
Screening for respiratory symptoms and FTOCC	Yes	Yes	Yes	Not specified	Yes	Yes	Yes	Not specified
Screening for GI symptoms	Yes	Yes	Not specified	Not specified	Yes	Yes	Not specified	Not specified
CT chest	No	**Yes**	Not specified	Not specified		Not specified	Not specified	Not specified

This article is protected by copyright. All rights reserved.

Accepted Article

Pre-emptive COVID-19 testing	**Can be considered**	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
Patient precautions	ABHR, surgical face masks, avoid close contact	Surgical face masks	Surgical face masks	Not specified	Face mask, gloves	Surgical mask, with gloves if intermediate-high risk	Not specified	Not specified
Waiting area policy	no visiting (unless compassionate grounds), restrict number of cases waiting	Not specified	Not specified	Not specified	No visiting unless patient requires specific assistance or translation service	Caregivers and relatives of the patients are strictly prohibited to enter the endoscopy department unless the patient requires specific assistance and translation service.	Isolation precautions for COVID-19 positive patients, or those awaiting test results Avoid bringing patients (or their escorts) into the medical facility who are over age 65 or have one of the CDC recognized risks Keep all patients at an appropriate distance from each other (6 feet)	Not specified
Risk stratification	Yes (Upper GI high risk)	Yes (Upper GI high risk)	Yes	Yes (Upper GI high risk)	Yes (Upper GI potentially AGP)	Yes (Upper GI high risk)	Yes	Yes (Upper GI high risk)
Negative pressure room	For suspected or confirmed COVID-19 cases and bronchoscopy	Not specified	Not specified	Not specified	high-risk or positive for SARS-CoV-2	High-risk or positive for SARS-CoV-2	For COVID-19 positive patients, or those awaiting results	Not specified
PPE	High risk: N95 or equivalent, and water-resistant gowns (AAMI level 3)	Protection at **biosafety level 3** is required while performing all kinds of endoscopic	High-risk cases: with suspected or proven COVID-19 infection all staff should wear N95 or	Follows Public Health England guidance	PPE choice based on likelihood of COVID-19 infection High-risk: N95 or	Hairnet, goggles, mask, gown, **two pairs of gloves** different PPEs according to the	Gloves, mask, eye shield/goggles, face shields, and gown	High-risk: N95 or equivalent Non high-risk: surgical masks

This article is protected by copyright. All rights reserved.

Accepted Article

	Non-high risk: preferably with N95 or equivalent, and disposable gowns In common: hair net, face shield/goggles, gown and gloves	procedure In suspected or confirmed COVID-19 patients Protection at **biosafety level 2** is required for staff directly in contact with patients (such as N95 masks)	equivalent For all other endoscopy cases (including colonoscopy): surgical mask should be used In common: eye protection, full length water proof gown and gloves		equivalent, **two pairs of gloves** Low-risk: Surgical mask, gloves In common: hairnet, eyewear, waterproof disposable gowns	risk		In common: gloves, gown, facial protection and hairnet
N95 (or equivalent) extended use	Yes	Not specified	Yes	Not specified	Yes (up to 4 hours is acceptable)	Not specified	Yes	Not specified
N95 (or equivalent) re-use	No	Not specified	Not specified	Not specified	Not specified	No	**Yes**	Not specified
Endoscopy team member selection	Procedures to be done by senior/independent endoscopists. All staff kept at absolute minimum required for patient care and safety	Not specified	Not specified	Restricting numbers of staff in rooms for all procedures	Only essential endoscopy personnel should be present	Not specified	Only essential personnel should be present	Not specified
Endoscopy training	Training suspended	Not specified	Not specified	Limit trainees	Not specified	All staff involved in endoscopy department are invited to follow standardized	Implies that fellows who cannot participate in cases may be redeployed	Not specified

This article is protected by copyright. All rights reserved.

Accepted Article

						precautions as a measure for optimal infection control		
Patient recovery	Designated recovery rooms **Early use of reversal agents after sedatives**	Not specified	Not specified	Not specified	Masks replaced once patient has recovered from sedation sufficiently to maintain O2 above 90% on RA	Mask placed back on at the end of the procedure	Not specified	Not specified
CPR	**Special COVID-19 precautions**	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
Clerical support	Yes	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified
Phone FU	Can be considered	Follow-up for 14 days to ensure no infection	Not specified	Not specified	at 7 and 14 days after endoscopy for all patients until end of outbreak	at 7 and 14 days after endoscopy for all patients until end of outbreak	Not specified	Not specified

Accepted Article

This article is protected by copyright. All rights reserved.