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Original article

The global impact of COVID-19 on gastrointestinal endoscopy units: An international survey of endoscopists

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ABSTRACT

Background & study aims: Corona virus disease-19 (COVID-19) pandemic has markedly impacted routine medical services including gastrointestinal (GI) endoscopy. We aim to report the real-life performance in high volume GI endoscopy units during the pandemic.

Patients and methods: A web-based survey covering all aspects of daily performance in GI endoscopy units was sent to endoscopy units worldwide. Responses were collected and data were analyzed to reveal the effect of COVID-19 pandemic on endoscopy practice.

Results: Participants from 48 countries (n = 163) responded to the survey with response rate of 67.35%. The majority (85%) decreased procedure volume by over 50%, and four endoscopy units (2.45%) completely stopped. The top three indications for procedures included upper GI bleeding (89.6%), lower GI bleeding (65.6%) and cholangitis (62.6%). The majority (93.9%) triaged patients for COVID-19 prior to procedure. N95 masks were used in (57.1%), isolation gowns in (74.2%) and head covers in (78.5%). Most centers (65%) did not extend use of N95 masks, however 50.9% of centers reused N95 masks. Almost all (91.4%) centers used standard endoscopic decontamination and most (69%) had no negative pressure rooms. Forty-two centers (25.8%) reported positive cases of SARS-CoV-2 infection among patients and

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50 (30.7%) centers reported positive cases of SARS-CoV-2 infection among their healthcare workers.
Conclusions: Most GI endoscopy centers had a significant reduction in their volume and most procedures performed were urgent. Most centers used the recommended personal protective equipment (PPE) by GI societies however there is still a possibility of transmission of SARS-CoV-2 infection in GI endoscopy units.

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Introduction

As of 15th May 2020, around 4,338,658 confirmed cases and 297,119 deaths have been reported due to the most challenging infectious disease of the 21st century so far, COVID-19 [1]. COVID-19 is caused by a novel coronavirus, severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) that emerged in December 2019 in Wuhan, China as a cluster of cases with severe acute respiratory syndrome (SARS) [2]. Being highly contagious, SARS-CoV-2 not only spread exponentially throughout China, but also rapidly spread across more than 205 nations in most continents, hence declared a global pandemic [3]. Hospital settings are considered at higher risk for viral contamination and bidirectional human to human transmission among health care professionals and patients [4–6]. Data reported from the index SARS-CoV-2 outbreak in Hubei Province of China confirmed a three-fold higher rate of SARS-CoV-2 infection among health care workers than the general population [7]. In Italy, an estimated 20% of all COVID-19 infections could be present in health care workers [8] and similar findings were reported from the United States [5]. Being high aerosol-generating procedures (AGP) endoscopy procedures are considered as a potential source of airborne transmission. Identification of SARS-CoV-2 in the stool of infected patients has also raised concerns for fecal-oral route of transmission during colonoscopy [9–10]. Endoscopy requires close proximity to patients for a significant length of time, increasing the likelihood of endoscopists being exposed to infected secretions by either direct contact or through aerosol generation. Endoscopists and endoscopy staff may therefore have a higher risk of acquiring SARS-CoV-2 [11–13]. Several national and international gastrointestinal (GI) societies have released recommendations to prevent nosocomial transmission and protect healthcare workers and patients, advocating only performing emergent, urgent and semi-urgent (essential) endoscopic procedures and delaying elective endoscopic procedures during COVID-19 pandemic [14,15]. A review of published national and international guidelines emphasized the mandatory use of personal protective equipment (PPE) while performing endoscopies by all GI societies [14]. While deferring elective procedures could assist in decreasing the peak of SARS-CoV-2, this strategy is also leading to an exponentially expanding pool of patients with delayed procedures [5]. Moreover, the implementation of these recommendations in endoscopy units across the globe is challenging with wide variations in incidence and health care resources such as personnel, equipment and PPE [16]. In this study, we aimed to report the impact of the COVID-19 pandemic on endoscopy procedure volume, faculty effort in endoscopy, types of endoscopic procedures performed, usage of PPE and possible nosocomial infections at high volume gastrointestinal endoscopy units.

Patients and methods

Representatives of major endoscopy units in different countries were invited to participate in the survey. An initial email containing a brief introduction about the survey was sent to seek agreement of invited centers. A second email containing the detailed description of the survey together with the survey link was then sent one week later to those who agreed to participate in the survey. A follow up reminder through emails and social networks were sent 2 days before closure of the survey responses for those who did not respond initially. The survey was conducted from April 10–25, 2020. The survey (Supplementary method) had 4 main domains: details of the participating centers, response to COVID-19, use of PPE and post procedural detail. These included questions regarding demographics, procedure volume, type of procedures, waiting time for procedures before and during COVID-19 pandemic, the use of PPE in addition to possible endoscopist and staff exposure to COVID-19. All responses were collected in an online platform and data were analyzed anonymously to reveal the effect of COVID-19 pandemic on different aspects of GI endoscopic practice in the studied endoscopy units.

Sample size calculation

The primary objective of this study was to measure the percentage change in performed endoscopic procedures and to report changes in different aspects of work inside GI endoscopy units in response to COVID-19 in different countries. Based on a previous report by Repici and colleagues, 97.6% of the endoscopy units in one country reduced normal endoscopic activities due to COVID-19 [17]. We used the below equation to calculate the sample size for assuming a confidence interval level of 95%:

n = [DEFF*Np(1-p)]/ [$(d^2/Z^2_{1-\alpha/2}$*(N-1) + p*(1-p)]

Calculated Sample size: 45 endoscopy units will be required (margin of error of 5% and confidence interval of 41–49 units).

Statistical analysis

The data were entered and analyzed by using the Statistical package for social science SPSS (Release 22.0, standard version, copyright © SPSS; 1989-02). A descriptive analysis was performed, and results were presented as mean ± standard deviation for quantitative variables and number (Percentage) for qualitative variables. Comparative analysis was done using independent *t*-test and Pearson's Chi-square test where applicable. All p-values were two-sided and considered as statistically significant if <0.05.

Results

Participants

We invited 242 endoscopists of which 163 (67.35%) responded from 48 countries and 6 continents (Fig. 1). The majority (93.9%) of the participating centers were hospital-based endoscopy units affiliated with teaching hospitals.

Impact on endoscopy services

During COVID-19 pandemic, all centers (99%) except for two reduced their endoscopy volumes. The majority of the centers (85%) reported greater than 50% reduction in endoscopy volumes while 61% and 31% centers reported over 75% and 90% reduction respectively. Fig. 2 shows the average numbers and percentages

WHO regions	Africa	Americas	Europe	Eastern Mediterranean	South East Asia	Western pacific	Total
Frequency	7	55	7	37	19	38	163
Percentage	4.3%	33.7%	4.3%	22.7%	11.7%	23.3%	100%

Fig. 1. Participating centers (with subclassification according to WHO regions).

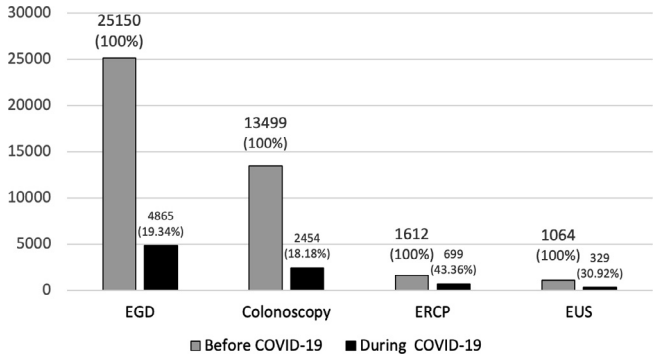

Fig. 2. Average numbers and percentages of main procedures/Week in participating centers before and during COVID-19.

of main endoscopic procedures performed every week before and during COVID-19 in the participating centers. Only four endoscopy units (2.45%) completely stopped doing endoscopic procedures during COVID-19 pandemic. The majority among the centers (87%) prioritized endoscopy procedures using urgent, emergent, or urgent and semi-urgent basis. While comparing the volumes of endoscopic procedures performed weekly before and during COVID-19 pandemic, over 80% decline has been observed in the average number of esophagogastroduodenoscopy (154.30 vs 29.85, $p < 0.0001$), Colonoscopy (83.08 vs 15.05, $p < 0.0001$), capsule endoscopy (1.37 vs 0.24, $p < 0.0001$) and manometry (3.02 vs 0.42, p0.002) procedures. Although the decline in the average number of endoscopic retrograde cholangiopancreatography procedures was statistically significant (9.92 vs 4.39, $p < 0.0001$) it was the lowest percentage decline among all endoscopic procedures (supplementary Table 1). A significant reduction in the number of days to perform endoscopies (5.16 vs 4.16, $p < 0.0001$), the number of endoscopists performing endoscopies per day (6.58 vs 3.36, $p < 0.0001$, 49.02% decline), nursing (12.55 vs 6.88, $p < 0.001$, 45.13% decline) and administrative staff (4.07 vs 1.90, p 0.001, 53.24% decline) have been reported during COVID-19 pandemic as compared to pre-pandemic time. Likewise, more than two-third reduction has been observed in the number of endoscopy referrals during COVID-19 pandemic (78.32 vs 60.36, $p < 0.0001$). The percentage increase in average waiting time of more than 2 weeks for both basic (42.9% vs 49.7%, $p < 0.001$) and advanced (22.1% vs 33.1%, $p < 0.001$) procedures was 15.7% and 50% respectively.

The most common indications for endoscopy during COVID-19 era included upper gastrointestinal (GI) bleeding (89.6%), lower GI bleeding (65.6%), cholangitis (62.6%) rest of procedures are presented in Fig. 3. The majority (75.5%) of participating centers were preparing a management plan for the waiting list anticipating the gradual resumption of all endoscopic procedures after the current phase of the pandemic. To accommodate outpatients a drastic increase (260.7%) in the use of telemedicine has also been observed (17.2% vs 62.0%, $p < 0.001$) after COVID-19 pandemic.

Preventive measures in response to COVID-19

Most (41.7%) participating centers followed the joint society recommendations from the American Gastroenterological Association/American College of Gastroenterology/American Society of Gastrointestinal Endoscopy for endoscopy during COVID-19 pandemic [5] while 7.4% followed World Endoscopy Organization [18], 4.9% followed Asian Pacific Society for Digestive Endoscopy [13] and 2.4% followed the British Society of Gastroenterology

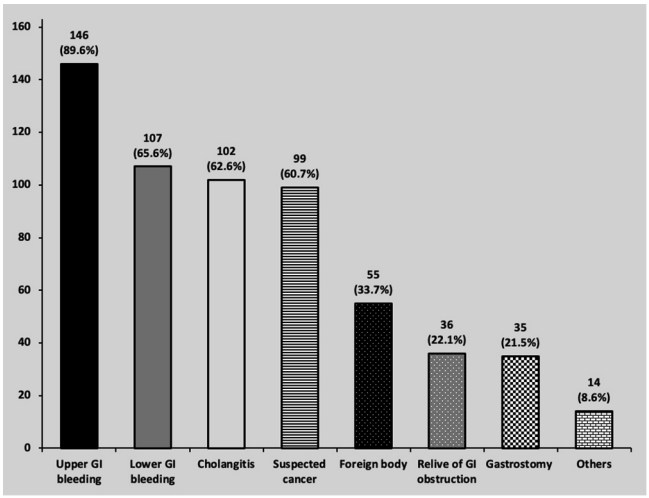

Fig. 3. Most common indications for endoscopic procedures during COVID-19.

[19]. The majority (93.9%) screened patients for possible COVID-19 prior to procedure with the most commonly used methods being: history of fever of more than 37.5° C, history of occupational exposure, history of clustering, a telehealth visit with the patient, and testing with a nasopharyngeal swab (54 centers, 33.13%) for suspected/probable cases. The majority (78.5%) of the centers considered dedicated teams (doctor, nurse, tech, anesthesia) for the delivery of endoscopic services to minimize personnel exposure and spread of infection after the onset of the COVID-19 pandemic. Most (91.4%) received appropriate education and training on infection control measures, including hand hygiene (95.1%), and on donning and doffing of PPE (82.8%).

Other than gloves, additional PPE commonly used for endoscopic procedures during COVID-19 era included (see Fig. 4): surgical masks (54.6%), N95 masks (57.1%), water-resistant isolation gowns (74.2%), head covers (78.5%), eye protection (69.3%), face shields (61.3%), N95 protection in association with face shields (39.9%), and shoe covers (61.3%). Most of the participating centers (65%) did not extend use (over 8 h) of N95 masks, however 50.9% of them reported reuse of N95 masks. 64.4% reported double-gloving routinely or for some procedures. Most (91.4–92%) centers used standard endoscopic decontamination for confirmed or suspected cases of SARS-CoV-2 infection, and 90.2% allowed extra time (at least 30 min) for sterilizing endoscopy room after each suspected or confirmed case of SARS-CoV-2 infection. Few centers added acetic acid, alcohol, prolonged time of decontamination or used high level disinfection. Prior to COVID-19, most (69%) had no negative pressure rooms. Thirty-three (30.26%) centers increased the number of negative pressure rooms during COVID-19. Few centers (18.4%) called patients back two weeks after procedures to ask about symptoms suggestive of COVID-19. Fifty (30.7%) centers reported positive cases of SARS-COV-2 infection among their health care workers and 42 (25.8%) reported positive cases of SARS-COV-2 infection among patients within two weeks of their procedure date. Strategies and preventive measures followed in response to COVID-19 pandemic are detailed in supplementary Table 2.

Discussion

The results of our survey represent the changes in endoscopy practice in response to the COVID-19 pandemic. Based on GI society guidelines, many hospitals stopped elective endoscopic procedures, diverted healthcare providers to participate in dedicated "COVID-19 teams" and planned a reduction in endoscopy staff. Most non-urgent endoscopic procedures have been restricted as a consequence of COVID-19, however the difference was significant (5 times larger numbers before COVID-19) with the common endoscopic procedures (EGD, colonoscopy, ERCP and EUS) which occur daily in most centers with EGD being the most affected. Previous reports from China showed marked decrease of the number of endoscopic procedures during COVID-19 compared to 6.3 times higher number of endoscopic procedures before COVID-19 [17]. Our results comply with different recommendations published from many GI endoscopy societies. Management of gastrointestinal hemorrhages and cholangitis were the most commonly encountered indications for performing endoscopy during COVID-19 pandemic. This is expected based on the urgency of the indication and similar to earlier reports from China, and reflects the recommendations from western professional societies [5,20,21]. The majority of participating centers are preparing their plans to resume endoscopy service. Resuming full capacity endoscopy service will be challenging as this will need continuous triage of

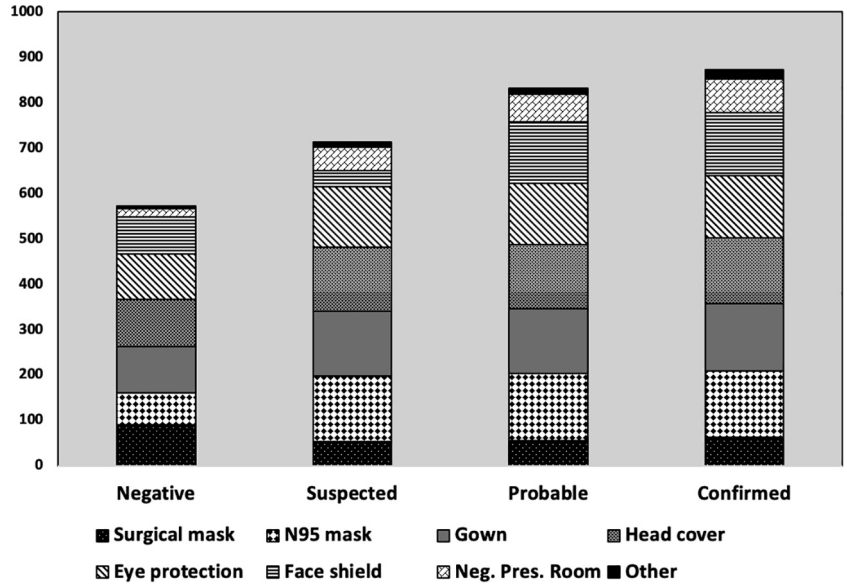

Fig. 4. PPE Use in different COVID-19 situations in the participating centers.

patients, frequent testing by serologic tests/ or swabs for SARS-CoV-2 viral load in addition to use of PPE [22]. However, this is inevitable as prolonged deferral of elective endoscopy procedures may, for example, delay diagnosis of resectable colorectal and other GI cancers, and increase the rate of preventable variceal bleedings in patients with liver cirrhosis with subsequent increase in mortality [23]. Some centers in Paris have used mobile on-call endoscopy teams (one physician and one nurse) with portable endoscopy set to rapidly and effectively respond to urgent calls in highly populated areas and to help in preventing infection dissemination among the whole team [24] A large number of centers have separated their healthcare providers into teams with priorities based on strategic resource allocation in the fight against COVID-19. Compartmentalizing teams may provide protection and conservation of endoscopists and other healthcare workers, conserve PPE, and allow optimal redeployment of staff to the teams that need them the most. In our study, most of the participating centers reported practicing proper hand hygiene. However, fewer number reported adequate training on the donning and doffing of PPE and about half of them reported reuse of N95 masks. This should motivate hospitals to improve the access and availability to training on the donning and doffing of PPE, explore the causes and consequences of reuse of N95 masks and to comply with majority of guidelines recommending this. During COVID-19 pandemic majority of endoscopists in the participating centers reported use of masks (over half of survey responders used N95 respirator masks), headcovers, shoe covers, eye protection and face shields for the majority of procedures. Over half of survey responders used N95 respirator masks and about half of them reported reuse of N95 masks. Based on our results there appears to be a wide variation with the type of PPE and combinations of PPE (masks and face shields) used. It seems that there are considerable percentage of GI endoscopy centers are not fully complying to guidelines recommendations. This also highlights the need to study the comparative effectiveness of PPE use with different endoscopic procedures. For example, some guidelines recommend the use of double gloves and checking their integrity before starting endoscopic procedures and this has to be evaluated [25]. Increased use of PPE is time consuming, increases the cost of healthcare and procedures and inappropriate use of PPE will result in their rapid depletion thereby jeopardizing the lives of essential healthcare workers. Therefore, it is important to standardize recommendations regarding the appropriate use of PPE based on the risk of exposure to balance the goals of protecting healthcare workers and minimizing associated costs [26,27]. When supplies of PPE are low, extended use is preferred over reuse due to lower risk of direct contamination resulting from frequent touching of the mask [28]. Similar to influenza viruses, SARS-CoV-2 is easily deactivated by alcohol and like SARS-CoV-1 it can be inactivated by glutaraldehyde-based and other disinfectants [29]. Therefore, no further precautions in addition to the standard endoscopic decontamination protocols are recommended. However, it is recommended not to reuse disposable accessories. Most centers applied standard decontamination protocols for confirmed/ suspected cases, and this is consistent with most recommendations released from eastern and western endoscopy societies [5,30]. Extra time should be allowed after each confirmed or suspected case of COVID-19 for cleaning and disinfecting endoscopy rooms using virucidal cleaning agents before the subsequent procedure. Availability of negative pressure rooms in endoscopy centers decreases the risk of infection resulting from aerosol generation and this should be preferred when available. Typically, endoscopic procedures for patients needing endotracheal intubation should be done in negative pressure rooms [31]. The extra time needed for cleaning and disinfecting endoscopy rooms and limited availability of negative pressure rooms will likely limit the number of procedures that can be done in a day after endoscopy units resume all procedures in the future. Follow up of patients after procedures to check for symptoms of COVID-19 was lower than we expected. This may be due to redeployment of endoscopy staff to COVID-19 teams resulting in a small number of staff assigned to endoscopy services. Follow-up of patients after endoscopic procedures may help the endoscopy unit monitor the effectiveness of its policies and adjust them based on the rate of post-procedure infections. Despite screening protocols, high level of training and competency in infection control precautions and proper use of PPE in the participating endoscopy units, positive SARS-CoV-2 infections were reported among patients, endoscopists and endoscopy staff. Infection rates among healthcare workers may be low in some parts of the world like in Italy (4.3–10%) [31] but it may be high as in China (2.09–29%) and the United States [5,32]. Continuous monitoring of infection control measures and adherence to PPE recommendations and training of all endoscopy staff on proper donning and doffing technique may decrease the rate of these reported infections. We acknowledge the limitations of our study based on reporting and recommend prospective studies to evaluate the effectiveness of current society recommendations, including infection control measures, PPE use and measuring outcomes in patients and healthcare workers in endoscopy. We also recommend continuous audits to evaluate adherence to guidelines recommendations regarding use of PPE, follow up call for patients (two weeks post procedure) should also be encouraged to detect any possible transmission of SARS-CoV-2 infection in GI endoscopy centers and negative pressure rooms should be increased in number and used when available. To our knowledge, our study is the largest international survey to date, adding important information to the current literature on the impact of COVID-19 on endoscopy services in hospital-based endoscopy units across the world. Our results will help understand the changes associated with such a pandemic in preparation for post recovery period and other potential pandemics.

In conclusion, our study highlights the significant global impact on endoscopy services, factors affecting endoscopy unit operation and safety of patients and healthcare workers during the pandemic. We believe that this information will help the international GI endoscopy community plan and prepare for the re-opening of endoscopy units for all endoscopy services. The information from our study may be used to improve existing guidelines, implement education and training on infection control practices, such as donning and doffing PPE to all endoscopy personnel, and identify barriers to resumption of elective endoscopic procedures.

Author contribution

MA, DT, ME and WL survey concept and design; AP, QT, LL, PA, participated in acquisition of data; RM analysis and interpretation of data; AS, RM, MA, SV drafting of the manuscript; ME, ZS, AA, AM, AL, critical revision of the manuscript for important intellectual content; Irina, DD, SG, EK, SE study supervision. All authors discussed the results and approved the final version of the manuscript.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajg.2020.08.008.

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