

## Original Article

## Control measures to prevent Coronavirus disease 2019 pandemic in endoscopy centers: Multi-center study

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**Aims:** To investigate control measures for COVID-19 pandemic in GIE centers in China.

**Methods:** This is a retrospective multi-center research, including seven centers. Data collection was from 1 February to 31 March 2020 and the same period in 2019.

**Results:** There were a total of 28 COVID-19 definite cases in these hospitals. Six out of seven GIE centers were arranged to shut down on 1 February, with a mean number of shutdown days of  $23.6 \pm 5.3$ . The actual workloads were only 10.3%–62.9% compared to those last year. All centers had a preoperative COVID-19 screening process. Epidemiological questionnaire, temperature taking and QR-code of journey were conducted. Chest CT scan was conducted during the shutdown period and continued in five centers after return to work. Antibody and nucleic acid test were applied in one to three

centers. All endoscopists had advanced PPE. Five centers used surgical mask and the rest used N95 mask. Six centers used goggles or face shield. Five centers selected isolation gowns and the rest selected protective suits. The change frequency of these PPE was 4 h. Sterilizing measures were improved in six centers. Five centers utilized ultraviolet and six centers strengthened natural ventilation. Four and six centers used peracetic acid during the period of shutdown and return to work, alone or matched with OPA or acidified water.

**Conclusions:** Many effective control measures were conducted in GIE centers during the outbreak, including patients' volume limitation, preoperative COVID-19 screening, advanced PPE and disinfection methods.

**Key words:** control measure, Coronavirus disease 2019, endoscopy, hospital infection

## INTRODUCTION

IN DECEMBER 2019, a cluster of pneumonia cases caused by an unknown pathogen was first reported in Wuhan, Hubei Province, China. A novel coronavirus (SARS-CoV-2) was identified as the etiological agent in early January 2020, and human-to-human transmission has been since confirmed.<sup>1,2</sup> The outbreak of COVID-19 spread rapidly and has now established a global pandemic. The main route of COVID-19 transmission

is via respiratory droplets and aerosol; while the possibility of fecal–oral transmission also exists.<sup>3</sup> As a kind of invasive procedure, gastrointestinal endoscopy (GIE) was an examination with high-risk exposure to COVID-19 infection. Meanwhile, there was a critical problem to solve the shortage of personal protective equipment (PPE). A majority of GIE centers in China were arranged to shut down after the Spring Festival Holiday. This is a retrospective descriptive multi-center study, with detailed data about control measures to prevent the COVID-19 pandemic, including patients' volume limitation, preoperative COVID-19 screening, advanced PPE and disinfection methods. As far as we know, this is the first multi-center study with detailed data to report on COVID-19 prevention in GIE centers in China.

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## MATERIALS AND METHODS

### Study design and participants

THIS IS A retrospective descriptive multi-center research, including seven GIE centers affiliated with Chinese major public hospitals. Data collection was from February to 31 March 2020 and the same period in 2019. This study was approved by the ethics committee of Peking University People's Hospital.

### Procedures

We obtained detailed data about general features, staff status and control measures during the outbreak, including patients' volume limitation, preoperative COVID-19 screening, PPE and sterilizing measures. All data were checked by two physicians (QH and JW).

### Outcomes

We described general features, staff status and control measures to prevent COVID-19 transmission in these seven enrolled GIE centers. Control measures included patients' volume limitation, strict preoperative COVID-19 screening steps, advanced PPE and disinfection procedures.

### Statistical analysis

All the analyses were conducted using SPSS version 19 software. Measurement data were described by mean and standard deviation. Enumeration data was described by percentage. The independent *t* test was used to compare continuous variables. The Chi-squared test was used to compare enumeration data. *P*-value < 0.05 was considered statistically significant.

## RESULTS

### General features and staff status

ALL THESE GIE centers were located out of Hubei Province. Four centers are located in Beijing, two centers located in Shaanxi Province, the rest located in Guangdong Province. One of these hospitals in Xi'an, Shaanxi Province is a COVID-19 designated hospital. They equip a total of 55 operating tables, and employ a total of 143 endoscopists and 96 nurse assistants. There were a total of 28 COVID-19 definite cases (7, 16 and 5 cases in the hospitals of Beijing, Shaanxi and Guangdong Province in sequence) and no cases of death in these hospitals in February and March. Moreover, there were no definite cases

and two suspected cases in the enrolled GIE centers. There was no definite or suspected COVID-19 patient undergoing GIE procedure during that period. Six out of seven GIE centers were arranged to shut down on 1 February, and returned to work successively at the earliest on 24 February, with a mean shutdown days of  $23.6 \pm 5.3$  (weekends excluded). The working time of an endoscopist was  $11.3 \pm 2.6$  days per month after return to work, while they presented for duty every day before. Similarly, the number of endoscopists on duty was  $4.6 \pm 0.8$  after return to work, significantly less than that before the shutdown ( $10.0 \pm 1.6$ , *P* = 0.009). The total number of endoscopic learners was 91 per month in February and March 2019, while the learners were informed to suspend training during the pandemic (Table 1).

### Patient volume

The patient volume declined sharply during the pandemic (Table S1). The change of amounts of endoscopic examinations between the pandemic and the same period last year were as follows: normal gastroscopy 1481/13646 (10.9%) cases, painless gastroscopy 944/6858 (18.2%) cases, normal colonoscopy 828/8001 (10.3%) cases, painless colonoscopy 626/5196 (12.0%) cases, capsule endoscopy 6/31 (19.4%) cases, enteroscopy 7/43 (16.3%) cases and endoscopic ultrasonography (EUS) 138/1114 (12.4%) cases. The change of amounts of therapeutic endoscopy were as follows: endoscopic mucosal resection (EMR) 65/1185 (5.5%) cases, endoscopic submucosal dissection (ESD) 35/238 (14.7%) cases, endoscopic retrograde cholangiopancreatography (ERCP) 216/420 (51.4%) cases. Similarly, the amounts of emergency endoscopy had a large gap, with 202/321 (62.9%) cases of gastroscopy and 43/73 (58.9%) cases of colonoscopy. The original plans of patient volume for February and March 2020 were collected (although not listed), almost equal to those of the last year. However, the actual workloads were only 10.3%–62.9% compared to those last year.

### Preoperative COVID-19 screening

As far as we know, there has been no case of hospital-acquired COVID-19 infection reported in these GIE centers. Patients must receive COVID-19 screening before GIE procedures during the outbreak. Family members who accompanied the patients should receive COVID-19 screening as well in six out of seven GIE centers (Table 2). The screening procedures were very strict. The epidemiological questionnaire and Quick Response-code (QR-code) of journey were checked for twice at the time of reservation

**Table 1** General features and staff status

	Center 1	Center 2	Center 3	Center 4	Center 5	Center 6	Center 7
Number of COVID-19 definite cases in hospital	4	1	0	0	2	16	5
Number of operating tables	5	3	5	10	16	6	10
Number of endoscopists	17	12	29	13	51	22	15
Number of nurse assistants	9	7	15	19	21	6	15
Shutdown date, mm-dd	02-01	02-01	02-01	02-01	NA	02-01	02-01
Return to work date, mm-dd	03-30	03-02	03-23	03-23	NA	03-02	02-24
Shutdown days (weekends excluded)	40	20	35	35	0	20	15
Working time of an endoscopist per month, days							
Return to work period	2	10	20	5	10	20	12
The same period last year	20	20	20	20	20	20	20
Number of endoscopists on duty per day							
Return to work period	1	3	5	5	7	5	6
The same period last year	8	6	7	13	18	10	8
Number of endoscopic learners per month at the same period last year	8	3	4	5	45	7	20

NA, not applicable. The definition of shutdown date was the date suspending routine appointment GIE procedures. The definition of return to work date was the date resuming routine appointment GIE procedures.

and just before the procedure. QR-code of journey is a code stored in the personal mobile phone, recording the departure from local place within 2 weeks. Temperature taking was conducted just before the examination. Antibody test and nucleic acid test of SARS-CoV-2, chest CT scan, and other methods (BR, CRP) were all best conducted within three days, or no more than a week, before GIE. Patients with negative screening results were allowed to undergo the GIE procedure. For unqualified patients, doctors would postpone the examinations or perform the procedure with advanced PPE.

The screening contents in different GIE centers were designed independently, not exactly the same. In each GIE center, there was a mean of five (range four to six)

steps during the shutdown period and a mean of four (range three to five) steps during the period of return to work for patients. The reduction of screening steps was statistically significant ( $P = 0.041$ ). Epidemiological questionnaire, temperature taking and QR-code of journey were conducted in all GIE centers. All GIE centers conducted chest CT scan during the shutdown period, which was continually used in five centers after return to work. Antibody test and nucleic acid test of SARS-CoV-2 were applied in one to three centers. One center asked patients to receive the tests of blood routine (BR) and C-reactive protein (CRP). The screening contents for the family member were similar to those for the patients.

**Table 2** COVID-19 screening strategies

Subjects	Number of GIE centers			
	Patient		Family member	
	Shutdown	Return to work	Shutdown	Return to work
COVID-19 screening				
Yes	6 (100%)	7 (100%)	5 (83%)	6 (86%)
Epidemiological questionnaire	6 (100%)	7 (100%)	5 (83%)	6 (86%)
Temperature taking	6 (100%)	7 (100%)	5 (83%)	6 (86%)
QR-code of journey	6 (100%)	7 (100%)	5 (83%)	6 (86%)
Antibody test of SARS-CoV-2	3 (50%)	1 (14%)	1 (17%)	0
Nucleic acid test of SARS-CoV-2	2 (33%)	1 (14%)	1 (17%)	0
Chest CT scan	6 (100%)	5 (71%)	3 (50%)	0
BR, CRP	1 (17%)	1 (14%)	1 (17%)	0

## Advanced PPE

Based on the screening results, all GIE centers conducted hierarchical advanced protection (Table 3). Five GIE centers used disposable surgical mask, one center used N95 mask and the remaining one used both of them simultaneously during the outbreak. Disposable cap and shoe cover were used in all GIE centers during the outbreak. All centers except one used goggles or face shield. Three centers selected disposable isolation gown, two centers selected protective suits and the rest used both disposable and non-disposable isolation gowns simultaneously during the outbreak. Four centers used two pairs of latex gloves and the rest used only one pair. The change frequency of PPE, except gloves, was 4 h. The PPE mentioned above was used for patients with negative results of COVID-19 screening, not for suspected or definite cases.

## Advanced endoscopic disinfection

Six out of seven GIE centers conducted advanced sterilizing measures throughout the pandemic (Table 4). Wiping instruments' surface and floor with 500 mg/L chlorine-releasing agents (CRAS) was a basic measure. Ultraviolet was used for 30–60 min at a time in five centers. Natural ventilation was strengthened during the outbreak in six centers. For endoscope disinfection, four and six centers used peracetic acid during the period of shutdown and return to work. It could be used alone or matched with orthophthalaldehyde (OPA) or acidified water. Contaminated

flexible endoscopes were put into medical garbage bags and carried to cleaning rooms by nurse assistants. The disinfection procedures were then performed by qualified professional nurses. Most of the instruments were disposable. Non-disposable instruments for therapeutic endoscopy were all sterilized following the Spaulding Classification.<sup>4</sup> The sterilizing measures of instruments were not changed during the outbreak. The sterilizing measures mentioned above were used for patients with negative results of COVID-19 screening, not for suspected or definite cases.

## DISCUSSION

THE COVID-19 PANDEMIC is spreading at a rapid pace. Since December 2019, the local and national governments of China have taken unprecedented measures in response to the COVID-19 outbreak caused by SARS-CoV-2. COVID-19 is transmitted through respiratory droplets, physical contact, and aerosols, and there is evidence of human-to-human transmission.<sup>5</sup> GIE is an invasive procedure with high-risk exposure to viral infection for both doctors and patients. In addition, a significant number of patients can exhibit GI symptoms, including diarrhea.<sup>6,7</sup> Wu *et al.*<sup>8</sup> reported that 55% fecal samples of COVID-19 patients were positive for SARS-CoV-2 RNA and their data suggested the possibility of extended duration of viral shedding in faeces, for nearly five weeks after the patients' respiratory samples tested negative for SARS-CoV-2 RNA. The pandemic was spreading all over the country in late January. These seven hospitals in our study are all located out of Hubei Province. One of them in Xi'an, Shaanxi Province is a COVID-19 designated hospital. There had been 139, 87 and 436 COVID-19 definite cases in these three areas and one fatal case in Beijing at the end of January.<sup>9</sup> Then definite cases increased to 580, 253 and 1494; and fatal cases had increased to 8, 3 and 8 in these three areas until the end of March.<sup>10</sup>

In order to prevent COVID-19 transmission in GIE centers, elective endoscopy procedures have been postponed until the pandemic is under control.<sup>11</sup> In our study, most GIE centers shut down on 1 February, after the Spring Festival Holiday. The limitation of patient volume was elastic. GIE centers limited patient volume following the instructions of their hospitals, whose leaders would refer both to the local situation of COVID-19 pandemic and the arrangement of higher authorities. Staff managing endoscopy reservations kept working overtime to inform all patients with reservations that their procedures were postponed. Furthermore, the work plan was published in the clinic, internet and media simultaneously. The GIE centers resumed work successively in late February, with the same variation tendency of the outbreak.

**Table 3** Application of PPE in GIE centers

Subjects	Number of GIE centers		
	Shutdown	Return to work	The same period last year
Disposable medical mask	0	0	3 (43%)
Disposable surgical mask	5 (83%)	6 (86%)	4 (57%)
N95 mask	1 (17%)	2 (29%)	0
Latex gloves (one pair)	2 (33%)	3 (43%)	6 (86%)
Latex gloves (two pairs)	4 (67%)	4 (57%)	1 (14%)
Disposable cap	6 (100%)	7 (100%)	6 (86%)
Non-disposable cap	0	0	1 (14%)
Goggles	6 (100%)	6 (86%)	0
Face shield	5 (83%)	6 (86%)	0
Shoe cover	6 (100%)	7 (100%)	3 (43%)
Disposable isolation gown	3 (50%)	4 (57%)	0
Non-disposable isolation gown	2 (33%)	3 (43%)	7 (100%)
Protective suit	2 (33%)	2 (29%)	0

**Table 4** Sterilizing measures of GIE centers

Period/disinfection frequency	Operation room							Endoscope						
	Center 1	Center 2	Center 3	Center 4	Center 5	Center 6	Center 7	Center 1	Center 2	Center 3	Center 4	Center 5	Center 6	Center 7
Shutdown	① ②(30 min) ③	① ②(30 min) ③	②(60 min) ③	① ②(60 min) ③	NA	① ②(60 min) ③	① ②(60 min) ③	⑤(10 min) ⑦(wash) ⑥(10 h)	⑦(wash) ⑥(10 h)	⑧(20 min)	⑤(5 min)	NA	⑧(5 min) ⑤(10 min)	⑤(10 min)
Frequency	1/P ①②2/D; ③persistently	①②2/D; ③persistently	2/D	1/P	NA	①②1/P; ③persistently	①②1/P; ③persistently	1/P	1/P	1/P	1/P	NA	1/P	1/P
Return to work	① ②(30 min) ③	① ②(30 min) ③	① ④	① ②(60 min) ③	① ②(60 min) ③	① ②(60 min) ③	① ②(60 min) ③	⑤(10 min) ⑦(3 min)	⑦(3 min)	⑤+⑧(20 min)	⑤+⑦+⑧(5 min)	⑦(5 min) ⑤(15 min) ⑦(5 min)	⑧(5 min) ⑤(10 min)	⑤(10 min)
Frequency	1/P ①②2/D; ③persistently	①②2/D; ③persistently	①2/D; ④1/D	2/D	①1/P ②③3/D	①②1/P; ③persistently	①②1/P; ③persistently	1/P	1/P	1/P	1/P	1/P	1/P	1/P
The same period last year	① ③	① ③	① ④	① ③	① ③	① ③	① ③	⑥(10 min) ⑦(3 min)	⑦(3 min)	⑤+⑧(20 min)	⑤+⑦+⑧(5 min)	⑤(15 min) ⑦(5 min)	⑧(5 min)	⑤(10 min)
Frequency	2/D	2/D	①2/D; ④1/D	2/D	1/D	①2/D; ③persistently	①2/D; ③persistently	1/P	1/P	1/P	1/P	1/P	1/P	1/P

NA, not applicable; ① Wipe instruments' surface and floor (500 mg/L CRAS); ② ultraviolet; ③ natural ventilation; ④ electronic air cleaner; ⑤ 0.3% peracetic acid; ⑥ glutaraldehyde; ⑦ acidified water; ⑧ OPA. 1/P: once per person; 1/D: once a day; 2/D: twice a day; 3/D: three times a day. The sequences listed in the table were the execution steps.

This decision was also made by the hospital itself based on its own situation. There were four GIE centers in Beijing in our study, three of which, with a total of five definite COVID-19 cases, shut down during the pandemic. They returned to work on 2, 23, 30 March successively. The outbreak was gradually under control in late February in Beijing. There were a total of 16 days and 5 days from 7 to 22 March and from 24 to 28 March with no new local cases in Beijing. Considering the large amount of gastroenterology patients in the emergency department, one GIE center with two definite cases didn't shut down during the two-month outbreak, but it limited patient volume. On the other hand, until the end of March it had reported a total of 164 cases from foreign countries to Beijing, which was the most around the country.<sup>12</sup> Epidemic prevention work had transferred to focus on the cases from foreign countries in late March. Consequently, most GIE centers kept advanced PPE and disinfection measures after return to work.

The duration of low patient volume in GIE centers was effective to control hospital-acquired COVID-19 infection and solve the shortage of PPE. The patient volumes for all kinds of GIE decreased markedly; only 10.3%–62.9% compared to those last year. The low patient volume attributed to not only the artificial limitation, but also the patients' fear of hospital infection. There was a large gap of patient volume between the same periods of 2020 and 2019. In addition, the working time of an endoscopist decreased to  $11.3 \pm 2.6$  days per month and the number of endoscopists on duty declined to  $4.6 \pm 0.8$  after return to work. On the other hand, at the height of the pandemic, most GIE centers only performed emergency endoscopy for acute life-threatening massive GI hemorrhage. As the indication was grasped more strictly than ever before, the amounts of emergency GIE declined as well. Although CT scan is not recommended for GI cancer screening,<sup>13,14</sup> but only for cancer staging,<sup>15,16</sup> it is so safe and effective that CT scan might be conducted more actively on patients with alarming symptoms and opportunities for screening during the pandemic. Considering the relatively low price and high inspection speed of CT scan in China, the chest could be scanned at the same time for the preparation of COVID-19 screening. Once the patient was suspected of GI cancer by the CT scan, he could undergo GI endoscopy directly without a repetitive chest CT scan.

To avoid COVID-19 infection, strict and effective preoperative screening strategies are necessary. No specific drug is currently available and a vaccine will not be available for several months. The only approaches that we currently have to stop the virus transmission are those of classical pandemic control, such as case isolation, contact tracing and quarantine, physical distancing and hygiene measures.<sup>17</sup> Patients

and their accompanying family members were asked to receive COVID-19 screening. The fraction of undocumented but infectious cases is a critical epidemiological characteristic that modulates the pandemic potential of an emergent respiratory virus.<sup>18</sup> These cases often experience mild, limited or no symptoms and hence go unrecognized.<sup>19</sup> More than 40% of all COVID-19 infections may be transmitted prior to the index case becoming symptomatic.<sup>20</sup> The screening steps were very strict. Although the single part of the screening strategies may have defects, the combination will be much more efficient.<sup>21</sup> The epidemiological questionnaire, QR-code of journey and temperature taking are rapid, economic and effective methods for COVID-19 screening. Chest CT scan is a sensitive and accurate measure of screening, conduction of which is recommended. The antibody and nucleic acid test should be applied on a special population, such as patients from pandemic areas.

Based on the screening results, GIE centers conducted hierarchical advanced protection. The screening strategies contributed to solve the shortage of PPE and avoid excessive protection. For patients with negative screening results, disposable surgical mask and isolation gowns could provide adequate protection to perform procedures. Disposable cap, shoe cover, goggles and face shield were necessary throughout the pandemic. Although the best change frequency of these PPE was once per person,<sup>22</sup> the actual frequency was 4 h at that time for the reason of PPE shortage. Considering the strict preoperative screening strategies of COVID-19, this compromise should be acceptable. In addition, sterilizing measures were equal of importance to interrupt viral transmission. Several guidelines for standardizing cleansing and disinfection of GIE have been published, including recent guidelines especially for the COVID-19 pandemic.<sup>23,24</sup> Wiping instruments' surfaces and floor with 500 mg/L CRAS was the basic measure to interrupt contact transmission. Most GIE centers conducted advanced measures of disinfection. Ultraviolet was widely used for its certain effect of killing the virus. Because of the efficiency and convenience, natural ventilation was equally important. As far as we know, there has been no case of hospital-acquired COVID-19 infection reported in all these GIE centers.

## CONCLUSIONS

**M**ANY CONTROL MEASURES to prevent the spread of the COVID-19 pandemic were conducted in GIE centers during the outbreak, including patient volume limitation, preoperative COVID-19 screening, advanced PPE and disinfection methods. These measures were so effective that no case of hospital-acquired COVID-19 infection had been reported in the GIE centers.

## CONFLICT OF INTERESTS

**A**UTHORS DECLARE NO conflict of interests for this article.

## FUNDING INFORMATION

**N**ONE.

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### SUPPORTING INFORMATION

ADDITIONAL SUPPORTING INFORMATION may be found in the online version of this article at the publisher's web site.

**Table S1** Patient volume during the same period over two consecutive years.