

## The influence of the SARS-CoV-2 pandemic on esophagogastric cancer services: an international survey of esophagogastric surgeons

Sivesh K. Kamarajah,<sup>1</sup> Sheraz R. Markar,<sup>2,3</sup> Pritam Singh,<sup>4</sup> Ewen A. Griffiths,<sup>5</sup> on behalf of the Oesophagogastric Anastomosis Audit Group\*

<sup>1</sup>Northern Oesophagogastric Unit, Royal Victoria Infirmary, Newcastle upon Tyne, UK, <sup>2</sup>Department of Upper Gastrointestinal Surgery, St. Mary's Campus, Imperial College London, London, UK, <sup>3</sup>Department of Molecular Medicine and Surgery, Karolinska Institute, Stockholm, Sweden, <sup>4</sup>Department of Upper Gastrointestinal Surgery, Royal Surrey County Hospital, London, UK, and <sup>5</sup>Department of Upper Gastrointestinal Surgery, Queen Elizabeth Hospital, Birmingham, UK

**SUMMARY. Background:** Several guidelines to guide clinical practice among esophagogastric surgeons during the COVID-19 pandemic were produced. However, none provide reflection of current service provision. This international survey aimed to clarify the changes observed in esophageal and gastric cancer management and surgery during the COVID-19 pandemic. **Methods:** An online survey covering key areas for esophagogastric cancer services, including staging investigations and oncological and surgical therapy before and during (at two separate time-points—24th March 2020 and 18th April 2020) the COVID-19 pandemic were developed. **Results:** A total of 234 respondents from 225 centers and 49 countries spanning six continents completed the first round of the online survey, of which 79% ( $n = 184$ ) completed round 2. There was variation in the availability of staging investigations ranging from 26.5% for endoscopic ultrasound to 62.8% for spiral computed tomography scan. Definitive chemoradiotherapy was offered in 14.8% (adenocarcinoma) and 47.0% (squamous cell carcinoma) of respondents and significantly increased by almost three-fold and two-fold, respectively, in both round 1 and 2. There were uncertainty and heterogeneity surrounding prioritization of patients undergoing cancer resections. Of the surgeons symptomatic with COVID-19, only 40.2% (33/82) had routine access to COVID-19 polymerase chain reaction testing for staff. Of those who had testing available ( $n = 33$ ), only 12.1% (4/33) had tested positive. **Conclusions:** These data highlight management challenges and several practice variations in caring for patients with esophagogastric cancers. Therefore, there is a need for clear consistent guidelines to be in place in the event of a further pandemic to ensure a standardized level of oncological care for patients with esophagogastric cancers.

**KEY WORDS:** COVID-19, esophageal cancer, esophageal surgery, gastric cancer, pandemic, SARS-CoV-2.

### INTRODUCTION

The World Health Organization declared a pandemic of coronavirus disease SARS-CoV-2 (COVID-19) on 11 March 2020.<sup>1</sup> Rapid spread of COVID-19 heavily affected healthcare systems worldwide, which led to vast and widespread changes in hospitals' structure to plan for increased intensive care unit (ICU) capacity to cope with the pandemic.<sup>2</sup> As a result, this pandemic not only affected COVID-19 patients, but also impacted the entire healthcare system including the provision of care for patients with cancer and surgery.<sup>3,4</sup>

Recent reports suggest an increased risk for cancer patients to develop severe complications when infected by COVID-19, with a similar pattern observed for those treated with surgery or chemotherapy.<sup>5</sup> Pursuing oncological care exposes both healthcare professionals and patients to become infected by COVID-19. However, the inability to receive oncological and/or surgical care seems to be an equally important prognostic threat for cancer patients.<sup>6</sup> The aggressive disease biology of esophageal and gastric cancer requires the continuation of oncological therapy during the COVID-19 pandemic.<sup>7</sup> However, thoughtful strategies need

\*Collaborating authors are presented in [Appendix 1](#).

*Conflicts of interest:* The authors declare that they have no conflict of interest.

to be developed to support healthcare professionals in clinical decision-making and ensure resources are allocated appropriately.<sup>8</sup>

This international survey aimed to clarify the changes observed in esophageal and gastric cancer management during the COVID-19 pandemic. This was performed by surveying international specialist surgeons with a focus on how the pandemic has affected their cancer services and how they have adapted their service with respect to: (1) cancer staging pathways, (2) multidisciplinary team (MDT)/tumor board meetings, (3) oncological therapy, (4) operative intervention, (5) pre-operative COVID-19 testing and (6) effect of the pandemic on esophagogastric cancer surgeons and redeployment.

## METHODS

### Survey

An online survey was developed through a consensus process involving a core group of investigators (Appendix I). The questionnaire was designed to cover a range of key areas for esophageal and gastric cancer, including staging investigations and oncological and surgical therapy before and during (at two separate time-points) the COVID-19 pandemic. This survey was circulated to all members of the international esophageal and gastric associations and study groups: Australian and New Zealand Gastric and Oesophageal Surgery Association, Association of Upper Gastrointestinal Surgeons (AUGIS), Dutch Cancer Audit, European Society of Diseases of Esophagus (ESDE), Gastric Cancer Surgery Trials Reported Outcomes Standardisation (GASTROS), International Society for Disease of Esophagus and Oesophagogastric Anastomosis Audit using Google Forms (Google LLC, Menlo Park, CA, USA). Only consultant or attending surgeons performing esophageal and gastric resections were invited to complete the online survey via email.

The survey consisted of two rounds with 40 questions (Appendix II and III) on baseline characteristics, the local impact of the COVID-19 pandemic on esophageal and gastric surgery (i.e. MDT meeting, availability of staging investigations, choice of oncological therapy, surgical resection and ICU capacity) and statements about prioritization of resection in the current era of the COVID-19 pandemic to gain a consensus. Each statement had to be appraised using the 'prioritization of patients for cancer surgery'<sup>9</sup> from the National Health Service England options: priority level 1 (curative therapy with a high [ $>50\%$ ] chance of success), priority level 2 (curative therapy with an intermediate [ $15\text{--}50\%$ ] chance of success), priority level 3 (noncurative therapy with a high [ $>50\%$ ] chance of  $>1$  year of life extension), priority level 4

(curative therapy with a low [ $0\text{--}15\%$ ] chance of success or noncurative therapy with an intermediate [ $15\text{--}50\%$ ] chance of  $>1$  year life extension), priority level 5 (noncurative therapy with a high [ $>50\%$ ] chance of palliation/temporary tumor control, but  $<1$  year life extension) and priority level 6 (noncurative therapy with an intermediate [ $15\text{--}50\%$ ] chance of palliation or temporary tumor control and  $<1$  year life extension).

The first round of the survey was conducted in the last week of March 2020 (Fig. 1A) and the second round was repeated in the last 2 weeks of April 2020 (Fig. 1B). Nonrespondents were sent two reminder emails. Respondents were asked to register their name and institution to prevent overlap of members between the same hospitals.

### Definitions

Critical care capacity was defined using the CRITCON level, which was originally developed in 2009 by the North West London Critical Care Network in response to the H1N1 influenza pandemic.<sup>10</sup> This grades ICU capacity into the following levels (CRITCON 0–4, corresponding to 'business as usual', 'normal winter', 'unprecedented', 'last resort' and 'triage'). Data for total confirmed cases per capita were derived from the 'Our World in Data',<sup>11</sup> which is a platform for global data on a broad range of conditions. Data on total confirmed COVID-19 cases per capita were grouped into tertiles (i.e. low [L-CoV], medium [M-CoV] and high [H-CoV]) derived from the database.

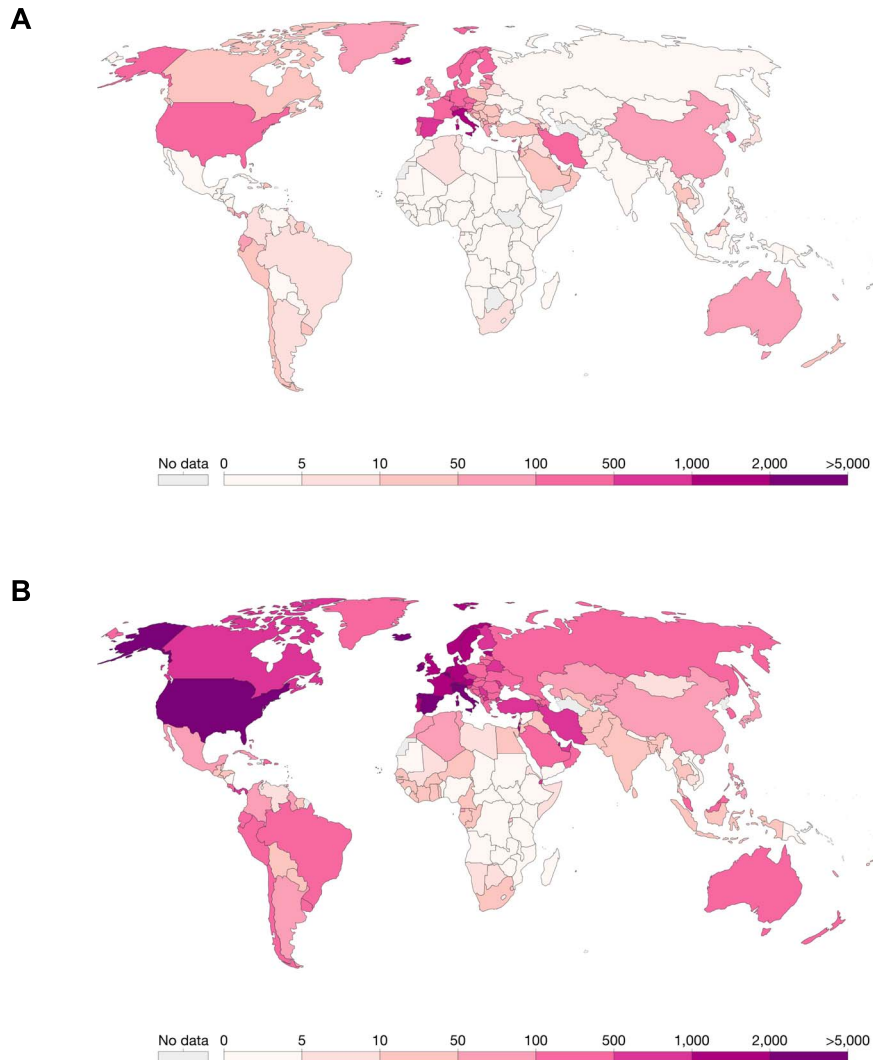
### Statistical analysis

Data analysis was performed using R Foundation Statistical software (R 3.2.2) (R Foundation for Statistical Computing, Vienna, Austria). Data were reported as number with percentage or as median with interquartile range. Categorical variables were compared using the chi-squared test. Non-normally distributed data were analyzed using the Mann–Whitney U test. Stratified sensitivity analyses were performed based on total confirmed cases per capita for each country on 24th March 2020 (round 1) and 18th April 2020 (round 2). All statistical significance was considered as two-tailed  $P$ -value  $<0.05$ .

## RESULTS

### Demographics of survey participants and centers

A total of 234 respondents from 225 centers and 49 countries spanning six continents completed the first round of the online survey (Supplementary data, Fig. S1). Baseline demographics of respondents are presented in Supplementary data, Table S1.



**Fig. 1** Global map demonstrating countries participating in round 1 and 2 of the survey and total COVID-19 cases per capita globally. (A) Total COVID-19 incidence on 24th March 2020. (B) Total COVID-19 incidence on 18th April 2020. \*These international maps demonstrating total COVID-19 confirmed cases per capita were obtained from the Our World in Data from <https://ourworldindata.org/coronavirus-data>.

Most respondents were upper gastrointestinal or esophagogastric surgeons ( $n = 158$ , 67.5%) working in an academic center ( $n = 217$ , 92.7%). The majority of centers had 501–1,000 hospital beds ( $n = 91$ , 38.9%) and 36.8% ( $n = 86$ ) of centers had 20 to 50 hospital ICU beds. In round 1, 81.6% had patients in their center with COVID-19 and 29.9% of centers had >51 inpatients with COVID-19. Majority of centers were at CRITCON level 2 ‘unprecedented’ ( $n = 96$ , 41.0%), followed by CRITCON level 1 ‘normal winter’ ( $n = 64$ , 27.4%) and CRITCON level 0 ‘business as usual’ ( $n = 38$ , 16.2%). Baseline characteristics of COVID-19-related demographics are presented in Table 1. Of the 234 respondents from round 1, 184

respondents (79%) completed round 2 of the survey as presented in Supplementary data, Table S1.

### Cancer protocols and MDT

In round 1, 88.6% of centers had standardized protocols available for the treatment of esophagogastric cancer patients during COVID-19 and these increased to 92.3% in round 2 (Table 1). Protocols were based on national guidelines in 23.9% and 28.8% of centers in round 1 and 2 respectively. There was a substantial increase in virtual MDT meetings from 36.3% to 48.4% from round 1 to 2, respectively (Table 1). In stratified analyses, rates of virtual MDT among

**Table 1** Baseline characteristics of COVID-19, cancer protocols, and multidisciplinary team among respondents stratified in round 1 ( $n = 234$ ) and 2 ( $n = 184$ ) of the survey

		Round 1	Round 2	P-value
<b>COVID-19</b>				
COVID-19 patients	No	34 (14.5)	29 (15.8)	0.2
	Yes	191 (81.6)	153 (83.2)	
	Unknown	9 (3.8)	2 (1.1)	
Number of COVID-19 patients	0–10	67 (28.6)	40 (21.7)	<0.001
	11–20	33 (14.1)	10 (5.4)	
	21–30	19 (8.1)	10 (5.4)	
	31–40	18 (7.7)	10 (5.4)	
	41–50	8 (3.4)	49 (26.6)	
	>51	70 (29.9)	59 (32.0)	
	Unknown	19 (8.1)	6 (3.2)	
CRITCON	Level 0 (normal)	38 (16.2)	22 (12.0)	0.5
	Level 1 (bad winter)	64 (27.4)	52 (28.3)	
	Level 2 (unprecedented)	96 (41.0)	87 (47.3)	
	Level 3 (full stretch)	30 (12.8)	21 (11.4)	
	Level 4 (last resort)	6 (2.6)	2 (1.1)	
<b>Cancer protocols and MDT</b>				
Protocol	No	29 (12.4)	16 (8.7)	0.5
	Yes—local	115 (49.1)	89 (48.4)	
	Yes—national	56 (23.9)	53 (28.8)	
	Yes—local and national	34 (14.5)	26 (14.1)	
MDT	No—limited numbers in the room	87 (37.2)	51 (27.7)	0.1
	No—they have had to be stopped	38 (16.2)	26 (14.1)	
	No—virtual MDT (video linkage)	85 (36.3)	89 (48.4)	
	Yes—face-to-face meetings	24 (10.3)	18 (9.8)	
<b>Staging modalities</b>				
Diagnostic endoscopy	Available	70 (29.9)	80 (43.5)	0.015
	Limited or delayed availability	142 (60.7)	92 (50.0)	
	Unavailable during COVID-19 pandemic	22 (9.4)	12 (6.5)	
Therapeutic endoscopy (EMR/ESD/stenting)	Available	78 (33.3)	75 (40.8)	0.2
	Limited or delayed availability	134 (57.3)	89 (48.4)	
	Unavailable during COVID-19 pandemic	22 (9.4)	20 (10.9)	
Spiral computed tomography scan	Available	147 (62.8)	144 (78.3)	0.002
	Limited or delayed availability	82 (35.0)	39 (21.2)	
	Unavailable during COVID-19 pandemic	5 (2.1)	1 (0.5)	
Endoscopic ultrasound	Available	62 (26.5)	52 (28.3)	0.7
	Limited or delayed availability	118 (50.4)	96 (52.2)	
	Unavailable during COVID-19 pandemic	54 (23.1)	36 (19.6)	
Position emission topography	Available	116 (49.6)	119 (64.7)	0.006
	Limited or delayed availability	86 (36.8)	43 (23.4)	
	Unavailable during COVID-19 pandemic	32 (13.7)	22 (12.0)	
Staging laparoscopy	Available	91 (38.9)	85 (46.2)	0.2
	Limited or delayed availability	96 (41.0)	61 (33.2)	
	Unavailable during COVID-19 pandemic	47 (20.1)	38 (20.7)	
<b>Cancer surgery</b>				
Prioritization	No	39 (16.7)	26 (14.1)	0.5
	Yes—local protocol	149 (63.7)	114 (62.0)	
	Yes—national protocol	46 (19.7)	44 (23.9)	
Resection	Consultants are assisted by other consultants (dual operating)	94 (40.2)	95 (51.6)	0.002
	Consultants are assisted by trainees	105 (44.9)	78 (42.4)	
	Consultants are training trainees	9 (3.8)	7 (3.8)	
	Resectional surgery has stopped	26 (11.1)	4 (2.2)	
<b>Postoperative management</b>				
Postoperative ICU	Never	15 (6.4)	13 (7.1)	0.3
	Routinely	106 (45.3)	96 (52.2)	
	Selectively	113 (48.3)	75 (40.8)	

Continued

Table 1 Continued

		Round 1	Round 2	P-value
Postoperative destination changes during COVID-19	No	61 (26.1)	80 (43.5)	<0.001
	Yes—consider operating or send patients to a different hospital	6 (2.6)	11 (6.0)	
	Yes—consider or send patients back to the ward or alternatives to ICU	124 (53.0)	77 (41.8)	
	Yes—operative surgery will be extremely rare	43 (18.4)	16 (8.7)	
Perceived morbidity with COVID-19 in esophagogastric cancer patients	Higher morbidity, but similar mortality	31 (13.2)	23 (12.5)	0.7
	Higher mortality	178 (76.1)	142 (77.2)	
	Similar risks to usual	9 (3.8)	10 (5.4)	
	Unknown	16 (6.8)	9 (4.9)	
Estimated postoperative COVID-19 infections in esophagogastric cancer patients*	0%	—	56 (30.4)	—
	1–10%	—	32 (17.4)	
	>10%	—	14 (7.6)	
	Unknown	—	82 (44.6)	
Estimated major complications associated with COVID-19 infections in esophagogastric cancer patients*	0%	—	51 (27.7)	—
	1–10%	—	20 (10.9)	
	>10%	—	35 (19.0)	
	Unknown	—	78 (42.4)	
Estimated 30-day mortality associated with COVID-19 infections in esophagogastric cancer patients*	0%	—	53 (28.8)	—
	1–10%	—	20 (10.9)	
	>10%	—	33 (17.9)	
	Unknown	—	78 (42.4)	

\*These questions were only asked in round 2 of the survey.

centers were significantly higher in countries with M-CoV and H-CoV incidence cases compared to L-CoV incidence cases in both round 1 (47.4% vs. 37.7% vs. 24.1%,  $P < 0.001$ ) and 2 (49.4% vs. 51.2% vs. 34.8%,  $P < 0.001$ ) (Supplementary data, Table S2).

### Staging investigations

There was variation in the availability of staging investigations in round 1 ranging from 26.5% for endoscopic ultrasound to 62.8% for spiral computed tomography (CT) scan (Fig. 2). Round 2 demonstrated significant increases in rates of diagnostic endoscopy (29.9% vs. 43.5%,  $P = 0.015$ ), spiral CT scan (62.8% vs. 78.3%,  $P = 0.002$ ) and position emission topography scan (49.6% vs. 64.7%,  $P = 0.006$ ) (Fig. 2; Table 1) in comparison to round 1. Limited variations were observed in stratified analyses by total COVID-19 cases between rounds (Supplementary data, Table S3).

### Oncological therapy

#### Esophageal adenocarcinoma

Standard pre-COVID-19 oncological therapies available for potentially curative esophageal adenocarcinoma included neoadjuvant chemotherapy (NCS) ( $n = 163$ , 69.1%) or chemoradiotherapy (NCRS) ( $n = 152$ , 64.4%) (Fig. 3A). Definitive chemoradiotherapy (DCRT) was offered in 14.8% of centers and significantly increased during the COVID-19 pandemic by almost three-fold in both round 1 and 2 (39.7% and 38.0%,  $P < 0.001$ ).

Stratified analyses demonstrated higher rates of adoption of DCRT in H-CoV centers in both round 1 and 2 compared to standard for esophageal adenocarcinoma (Supplementary data, Fig. S2, Table S4).

#### Esophageal squamous cell carcinoma

Standard pre-COVID-19 oncological therapies available for potentially curative esophageal squamous cell carcinoma included NCRS ( $n = 188$ , 80.3%) and DCRT ( $n = 110$ , 47.0%) (Fig. 3B). DCRT was offered in 47.0% of centers and significantly increased during the COVID-19 pandemic in both round 1 and 2 (64.5% and 73.9%,  $P < 0.001$ ). Stratified analyses demonstrated significantly higher rates of adoption of DCRT and H-CoV centers in both round 1 and 2 compared to standard for esophageal squamous cell carcinoma (Supplementary data, Fig. S2, Table S4).

#### Timing of surgery after neoadjuvant therapy

For timing of surgery after neoadjuvant therapy as standard pre-COVID practice, the majority of centers offered surgery 6 to 8 weeks following neoadjuvant therapy ( $n = 132$ , 56.4%) and only 4.3% and 0.9% of centers offered surgery after 10 to 12 weeks and >12 weeks, respectively. However, there was a five-fold significant increase in centers offering surgery 10 to 12 weeks after neoadjuvant therapy in round 1 and 2 (26.5% vs. 21.7%,  $P < 0.001$ ) (Table 2).

#### Changes to overall treatment

Overall changes to curative treatment for esophagogastric cancers are displayed in Figure 3C. While



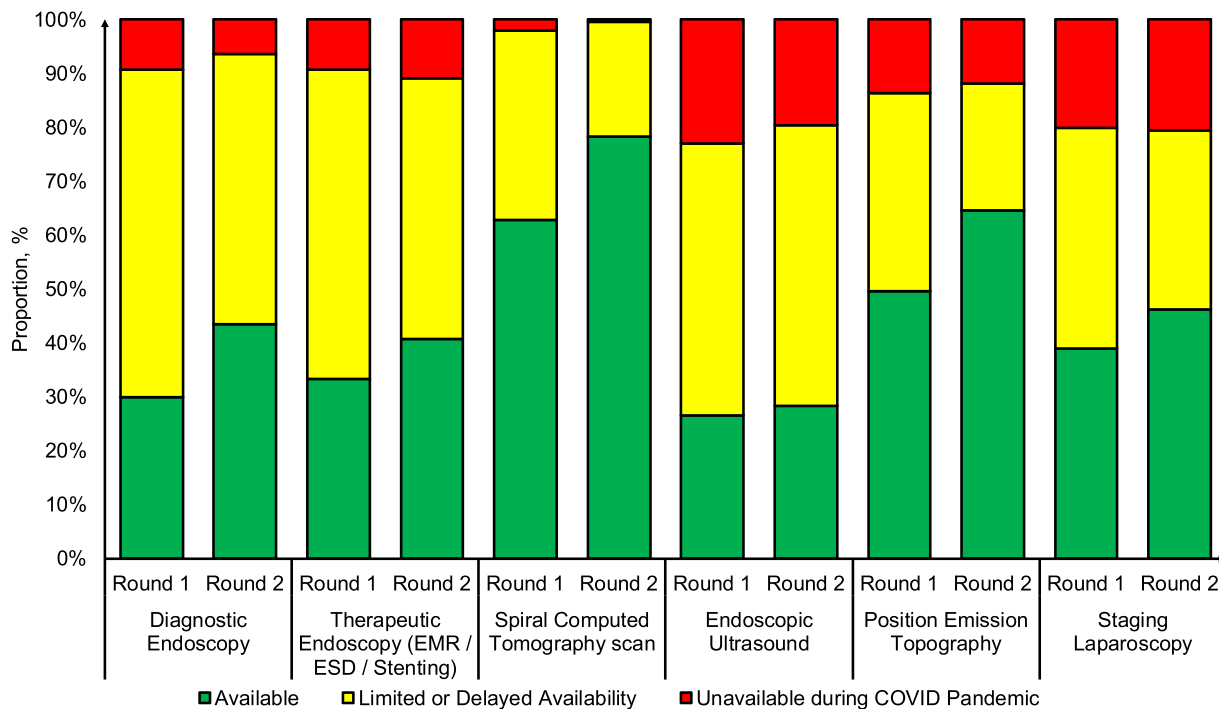


Fig. 2 Distribution of staging investigations availability across centers from round 1 and 2 of the survey during the COVID-19 pandemic.

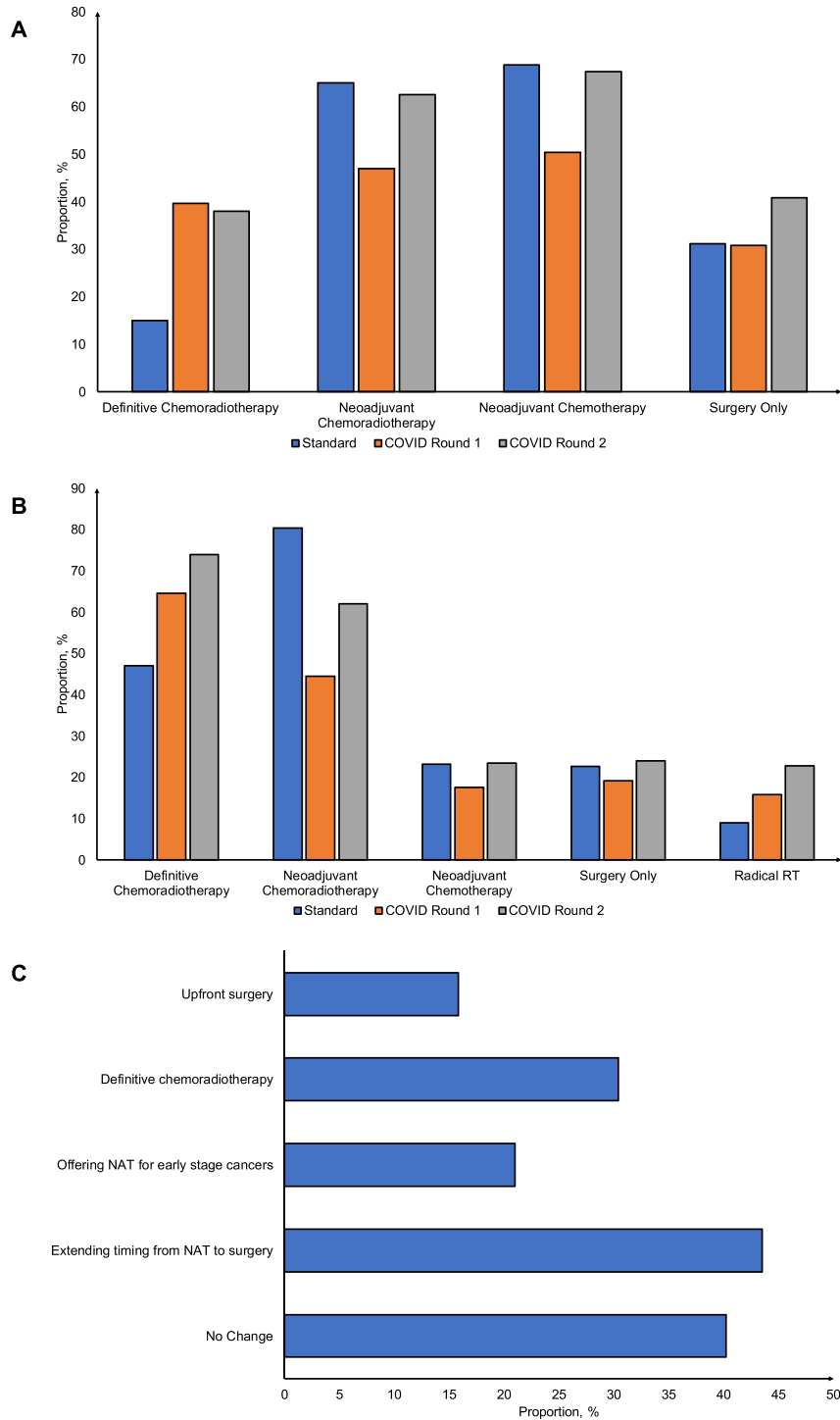
Table 2 Changes in oncological therapy for esophageal cancer among respondents stratified in round 1 (n = 234) and 2 (n = 184) of the survey

		Standard	Round 1	Round 2	P-value
<b>Esophageal adenocarcinoma</b>					
Definitive chemoradiotherapy	No	199 (85.0)	141 (60.3)	114 (62.0)	<0.001
	Yes	35 (15.0)	93 (39.7)	70 (38.0)	
Neoadjuvant chemoradiotherapy	No	82 (35.0)	124 (53.0)	69 (37.5)	<0.001
	Yes	152 (65.0)	110 (47.0)	115 (62.5)	
Neoadjuvant chemotherapy	No	73 (31.2)	116 (49.6)	60 (32.6)	<0.001
	Yes	161 (68.8)	118 (50.4)	124 (67.4)	
Surgery only	No	161 (68.8)	162 (69.2)	109 (59.2)	0.059
	Yes	73 (31.2)	72 (30.8)	75 (40.8)	
<b>Esophageal squamous cell carcinoma</b>					
Definitive chemoradiotherapy	No	124 (53.0)	83 (35.5)	48 (26.1)	<0.001
	Yes	110 (47.0)	151 (64.5)	136 (73.9)	
Neoadjuvant chemoradiotherapy	No	46 (19.7)	130 (55.6)	70 (38.0)	<0.001
	Yes	188 (80.3)	104 (44.4)	114 (62.0)	
Neoadjuvant chemotherapy	No	180 (76.9)	193 (82.5)	141 (76.6)	0.2
	Yes	54 (23.1)	41 (17.5)	43 (23.4)	
Surgery only	No	181 (77.4)	189 (80.8)	140 (76.1)	0.5
	Yes	53 (22.6)	45 (19.2)	44 (23.9)	
Radical radiotherapy	No	213 (91.0)	197 (84.2)	142 (77.2)	<0.001
	Yes	21 (9.0)	37 (15.8)	42 (22.8)	
<b>Timing of surgery after neoadjuvant therapy</b>					
<6 weeks		59 (25.2)	24 (10.3)	24 (13.0)	<0.001
6–8 weeks		132 (56.4)	46 (19.7)	69 (37.5)	
8–10 weeks		30 (12.8)	51 (21.8)	43 (23.4)	
10–12 weeks		10 (4.3)	62 (26.5)	40 (21.7)	
>12 weeks		2 (0.9)	44 (18.8)	8 (4.3)	
Neoadjuvant therapy is unavailable		1 (0.4)	7 (3.0)	0 (0)	

Standard treatment was defined as oncological therapy offered to patients by their center prior to the SARS CoV-2 pandemic whereas in round 1 and round 2 focusses on oncological therapy used during the SARS CoV-2 pandemic. P-values in tables represent statistical testing across each variable.

40.2% of respondents did not consider changes to overall treatment, 43.5% respondents considered extending timing from neoadjuvant therapy, 30.4% of respondents considered changing to DCRT and

21.0% considered offering neoadjuvant therapy for early stage cancers (i.e. T2N0 cancers). Despite these changes, when presented with case vignettes, majority of respondents favored proceeding with resection as



**Fig. 3** Distribution of oncological therapy available for esophageal cancers across centers from round 1 and 2 of the survey during the COVID-19 pandemic. (A) Esophageal adenocarcinoma. (B) Esophageal squamous cell carcinoma. (C) Overall changes to treatment strategies in esophagogastric cancer management to cope with the COVID-19 pandemic.

planned or proceeding to surgery (Supplementary data, Fig. S3).

**Perioperative cancer surgery**

**Surgical prioritization**

Prioritization of cancer resections was based on a national protocol in 19.7% of centers in round

1 and 23.9% in round 2 (Table 1). There were no significant differences in stratified analyses by total cases of COVID-19 per capita (Supplementary data, Table S5). We also assessed factors used in prioritization of cancer resections. In round 1, patient fitness was ranked first by 35.0% of respondents and tumor stage was ranked first by 34.4% of respondents. There were no significant differences in proportion

of respondents ranking both patient fitness and tumor stage first in round 2 (Fig. 4A). However, there was a significant increase in proportion of respondents ranking neoadjuvant timing as first from round 1 to round 2 (16.7% vs. 27.7%,  $P = 0.011$ ). To assess variation in prioritization of esophagogastric cancer resections, respondents were asked to prioritize case vignettes (Fig. 4B). Overall, there were no significant differences in ranking between cases in round 1 and 2. Prioritization of resections was based on early stage cancers or good physical fitness.

#### Routine COVID-19 testing of patients

Only 14.7% ( $n = 27$ ) were not performing routine testing of patients, 6.0% ( $n = 11$ ) used routine CT scanning only and 33.2% ( $n = 61$ ) used polymerase chain reaction (PCR) swab testing only. H-CoV centers had significantly higher rates of PCR swab testing than L-CoV or M-CoV centers (48.8% vs. 13.0% vs. 35.5%,  $P = 0.001$ ). In 32.1% of centers, there was a combination of either symptom assessment, use of CT scanning or PCR swab testing. COVID-19 PCR swab testing was available for centers in 92.2% of respondents. The COVID-19 PCR swab testing was available within 6 hours for centers in 36.4% of respondents, significantly quicker availability rates of in H-CoV centers compared to M-CoV and L-CoV (53.8% vs. 25.9% vs. 13.0%,  $P < 0.001$ ) (Supplementary data, Table S5).

#### Location of resection

Most respondents (46.7%,  $n = 86$ ) were performing cancer resections in the same hospital (usual theatres) while 27.7% ( $n = 51$ ) were performing cancer resections in the same hospital but separate theatres and 12.5% ( $n = 23$ ) were performing resections at separate COVID-19 cold/private sites. However, there were no significant differences in location of performing resection between total COVID-19 cases per capita (Supplementary data, Table S5).

#### Personal protective equipment

Of the respondents surveyed in round 2, 40.8% of respondents used personal protective equipment (PPE) for all resections and 44.6% only for those with suspected or confirmed COVID-19 patients. Only 14.7% of respondents did not use PPE. There were no significant differences in rates of PPE by total COVID-19 cases per capita across groups (Supplementary data, Table S5).

#### Resection approach

There was a significant increase toward dual consultant operating from round 1 to round 2 (40.2% vs. 51.6%,  $P = 0.002$ ), which was significantly higher in

H-CoV centers for round 1. However, this was not the case for round 2 as rates of dual consultant operating consistently increased across centers in countries with L-CoV, M-CoV and H-CoV case incidence (45.0% vs. 54.1% vs. 58.2%,  $P = 0.5$ ) (Supplementary data, Table S5). In 52.2% ( $n = 96$ ) of centers, there was still ongoing practice of minimally invasive surgery while only 12.0% ( $n = 22$ ) and 12.5% ( $n = 23$ ) were avoiding minimally invasive surgery in all or selected cases, respectively. In H-CoV centers, there was a significant reduction in the use of minimally invasive surgery in all cases compared to L-CoV or M-CoV (7.5% vs. 13.0% vs. 16.0%,  $P = 0.002$ ).

#### Postoperative management

##### Postoperative destination

Among respondents in round 1, only 45.3% of respondents send patients to ICU routinely and 48.3% of respondents send patients to ICU selectively following esophagogastric cancer resections (Table 1). In regards to postoperative destination, 2.6% of respondents were considering sending patients to a different hospital postoperatively during the COVID-19 pandemic during round 1, which significantly increased to 6.0% during round 2 ( $P < 0.001$ ) (Table 1). There were no significant differences in responses when stratified by total COVID-19 cases per capita (Supplementary data, Table S6).

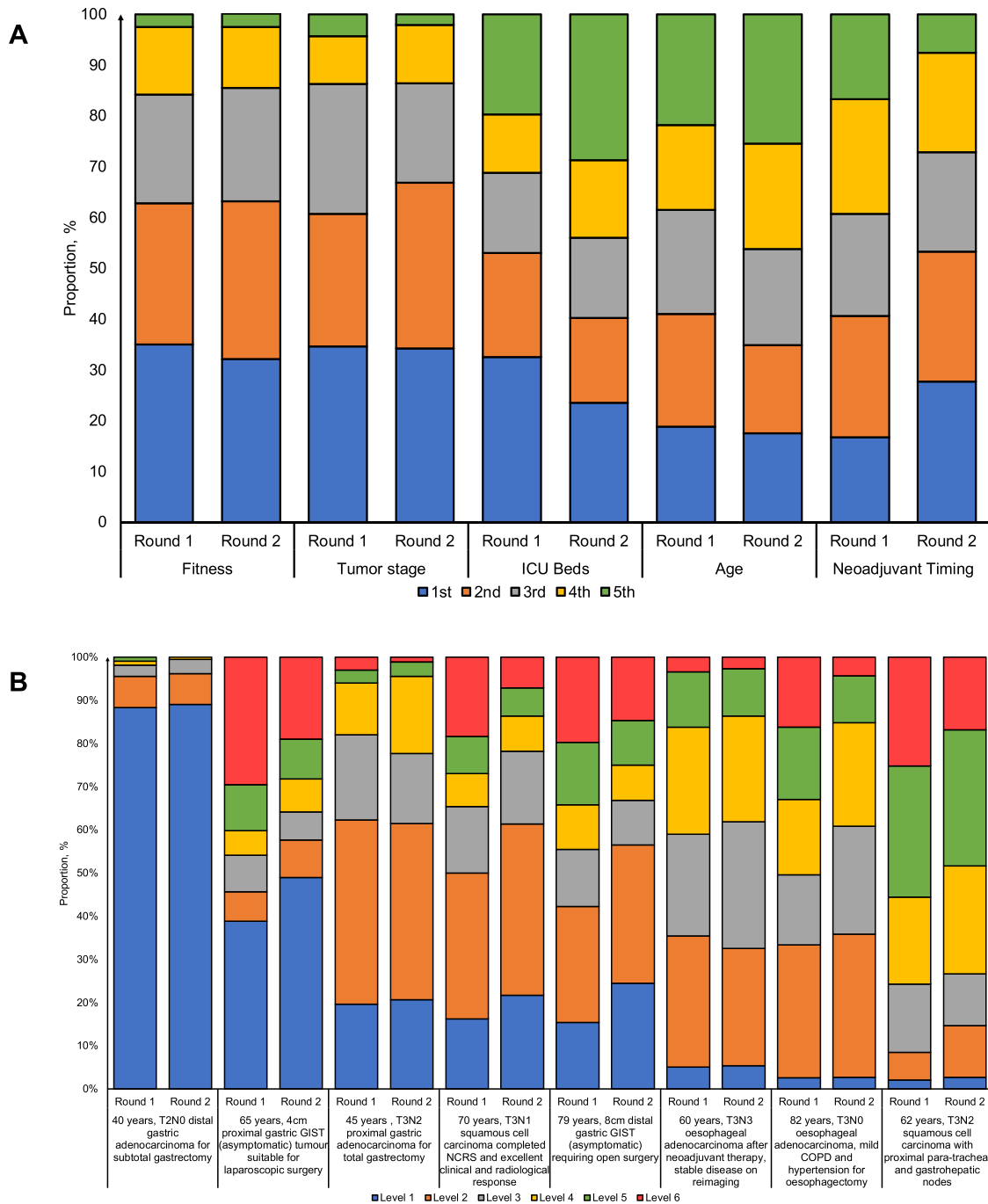
#### Impact of COVID-19 and surgeons

In round 2, we surveyed the impact of COVID-19 on esophagogastric surgeons. Among surgeons, 44.6% (82/184) have been symptomatic with COVID-19. Of the surgeons symptomatic with COVID-19, only 40.2% (33/82) had routine access to COVID-19 PCR testing for staff. Of those who had testing available ( $n = 33$ ), only 12.1% (4/33) had tested positive. Figure 3 illustrates redeployment of surgeons during the COVID-19 pandemic. While 67.9% remained in the same department, some 20.0% and 13.8% were redeployed to emergency department and HDU/ICU, respectively (Fig. 5).

## DISCUSSION

This international cross-sectional survey across 234 respondents from 225 centers and 49 countries spanning six continents demonstrates a high level of variation in availability of staging investigations, oncological therapy, decision-making regarding prioritization of cancer resections during the COVID-19 pandemic and perioperative management in cancer resections. The main findings of this survey include: (1) wide adoption of DCRT for esophageal adenocarcinoma and squamous cell carcinoma; (2) uncertainty and heterogeneity surrounding prioritization of patients

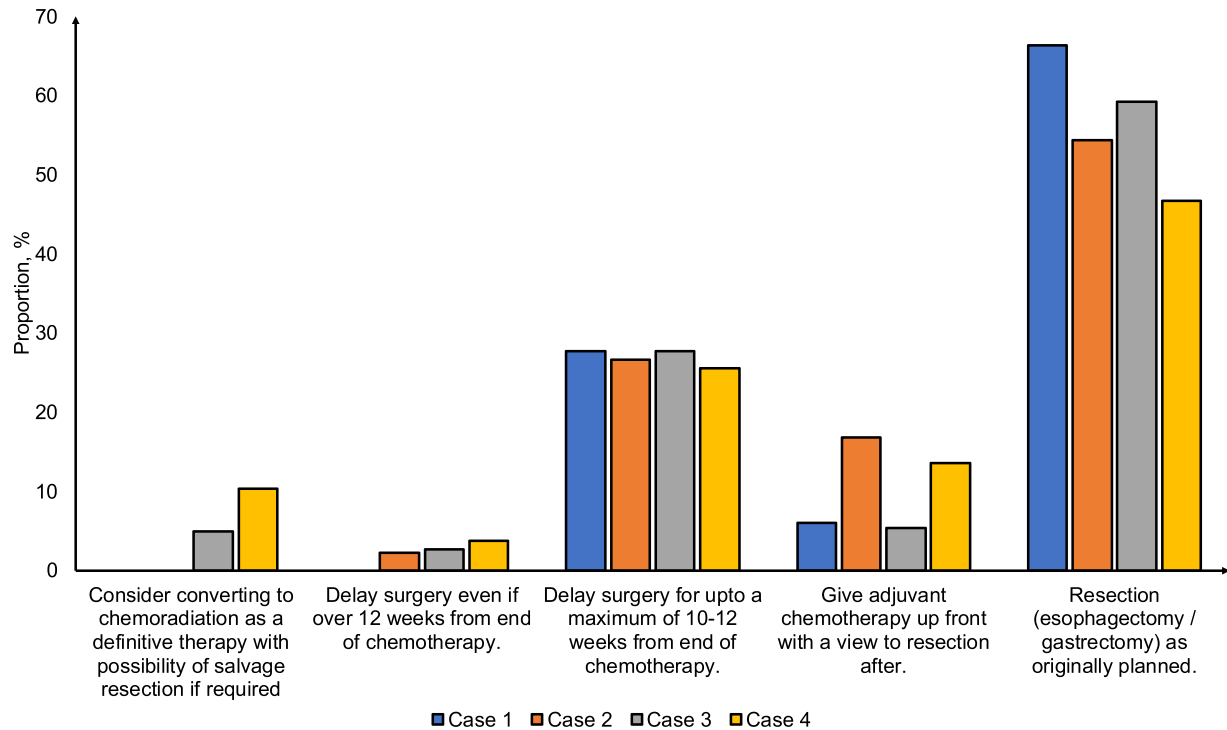




**Fig. 4** Distribution of ranking priority for esophagogastric cancer resections across centers from round 1 and 2 of the survey during the COVID-19 pandemic. (A) Prioritization factors. (B) Case vignettes. \*For Figure 4B, the definition of each level are as follows: level 1 (curative therapy with a high [ $>50\%$ ] chance of success); level 2 (curative therapy with an intermediate [ $15\text{--}50\%$ ] chance of success); level 3 (noncurative therapy with a high [ $>50\%$ ] chance of  $>1$  year of life extension); level 4 (curative therapy with a low [ $0\text{--}15\%$ ] chance of success or noncurative therapy with an intermediate [ $15\text{--}50\%$ ] chance of  $>1$  year life extension); level 5 (noncurative therapy with a high [ $>50\%$ ] chance of palliation/temporary tumor control but  $<1$  year life extension); and level 6 (noncurative therapy with an intermediate [ $15\text{--}50\%$ ] chance of palliation or temporary tumor control and  $<1$  year life extension).

undergoing cancer resections; and (3) high rates (44.6%) of workforce symptomatic from COVID-19 likely to impact delivery of cancer services during a pandemic. These data highlight the management challenges and several practice variations in caring for patients with esophagogastric cancers. Dissemination of data from this survey will improve understanding

of current international clinical practice during the COVID-19 pandemic. Further, this study has identified the need for clear consistent national or international guidelines to be in place in the event of a further pandemic to ensure a standardized level of oncological care for patients with esophagogastric cancers.



**Fig. 5** Distribution of redeployment of surgeons across centers from round 2 ( $n = 184$ ) of the survey during the COVID-19 pandemic stratified by total COVID-19 cases by low (L-CoV), middle (M-CoV) and high (H-CoV) groups.

### Oncological therapy

This survey has demonstrated broad shifts in oncological management of patients with both esophageal adenocarcinoma and squamous cell carcinoma toward use of DCRT. This likely reflects the uncertainty related to surgical capacity owing to the lack of HDU or ICU capacity. In the absence of robust randomized trial data, DCRT and neoadjuvant treatment followed by surgery have equivalent survival outcomes for esophageal squamous cell carcinoma.<sup>12,13</sup> The evidence base for DCRT is less strong for esophageal adenocarcinoma,<sup>13</sup> but reasonable outcomes were seen for this group in the SCOPE1 trial.<sup>14,15</sup> In this survey, there are also broad shifts to delaying time to surgery following neoadjuvant therapy, which could potentially affect prognosis. A meta-analysis of 13 studies involving 15,086 patients showed an interval longer than 7 to 8 weeks between the end of neoadjuvant CRT and surgery was significantly associated with an improved pathological complete response rate, but lower 2-year and 5-year overall survival.<sup>16</sup> The effect of delay after NCS is less certain, however, a recent US National Cancer Database study demonstrated that an additional delay to surgery by at least 4 weeks may not have a significant impact on patient survival or cancer progression.<sup>17</sup> In addition, data presented for esophageal and gastric cancers suggest that surgery could be potentially safe to postpone up to 28 and 30 weeks after diagnosis in patients receiving neoadjuvant treatment.<sup>17</sup> The ongoing NeoRes-II

randomized controlled trial evaluating timing of surgery after NCRS will provide level 1 evidence.<sup>18</sup>

### Cancer resection prioritization

There is a concern that limited HDU/ICU bed availability and the risk of postoperative SARS-CoV-2 infection will severely limit or preclude surgical intervention for esophagogastric patients. Therefore, prioritization of cancer resection patients most likely to benefit and be at low risk of complications is important. Several groups have developed guidelines and prioritization models, including AUGIS,<sup>19</sup> ESDE,<sup>20</sup> Thoracic Surgery Outcomes Research Network<sup>21</sup> and other groups<sup>22–24</sup> specifically for this patient group. The medically necessary, time-sensitive (MeNTS) score has been developed and systematically scores several factors (procedure timing and resource use, disease urgency and patient risk factors) for prioritizing surgical procedures across all surgical specialties.<sup>24</sup> This scoring system aims to triage MeNTS procedures, and appropriately weighs individual patient risks with the ethical necessity of optimizing resource allocation during the pandemic. This approach is applicable across a broad range of hospital settings (academic and community, urban and rural) and may be able to inform case triage as operating room capacity resumes once the acute phase of the pandemic subsides.

This survey highlights the prioritization of cancer resections by centers is based on patient fitness and

tumor stage. In our survey, surgeons appear to prioritize advanced tumors (i.e. high-risk nodal disease) due to high risk of disease progression.<sup>17</sup> Treatment decisions are further complicated by the fact most of the patients with esophagogastric cancer are in a ‘high-risk’ category for poor outcomes if they developed COVID-19 (elderly, cardiorespiratory comorbidities and obesity). In addition, the surgery (especially thoracotomy) can both impair lung function (i.e. one lung isolation, postoperative pain and pneumonia) and potentially expose clinical teams to aerosolized viral load (bronchoscopy, double-lumen endotracheal tube placement and endoscopy).<sup>21</sup>

### Screening and protection in COVID-19

Due to the high prevalence of pulmonary complications following esophagogastric surgery,<sup>25</sup> and the implications of postoperative COVID-19 infection, rates of asymptomatic infection, there is a convincing case for accurate preoperative testing of these patients prior to surgery. The Corona Virus Global Surgical Collaborative recommend performing routine COVID-19 testing for all patients who will undergo a surgical or interventional endoscopic procedure in institutions seeing high volumes of COVID-19 patients.<sup>26</sup> In addition, American College of Surgeons advised to wait for the results of COVID-19 testing in patients who may be infected, but no further recommendation surrounding cancellation or postponement of surgery in patients testing positive.<sup>27</sup> Routine screening may include symptomatic assessment via telephone triage several days before elective cancer surgery for risk stratification and preoperative CT scanning owing to high sensitivity up to 97%.<sup>28</sup>

### Minimally invasive surgery

Although previous research has shown that laparoscopy can lead to aerosolization of blood-borne viruses,<sup>29–31</sup> no specific robust research has been published in COVID-19 patients. Current available guidance from the Intercollegiate Royal College of Surgeons<sup>32</sup> and Society of American Gastrointestinal and Endoscopic Surgeons<sup>26</sup> offer inconsistent guidance that can be open to interpretation on performing minimally invasive surgery. This is reflected in this survey where 24.5% of respondents stopping minimally invasive surgery in all or selected cases.

### Surgical workforce

In our survey, 44.6% have been symptomatic with COVID-19. Of the surgeons symptomatic with COVID-19, only 40.2% (33/82) had routine access to testing for staff. Of those who had testing available ( $n = 33$ ), only 12.1% (4/33) had tested positive. Esophageal surgeons have a duty to self-isolate if they develop COVID symptoms and get appropriate

testing to avoid spreading the virus to other staff and patients in the hospital.

### Strengths and limitations

This survey has several strengths including its large sample size and that it performed two rounds capturing changes during the pandemic. In addition, a wide range of countries and continents, with differing COVID-19 disease incidence were captured. This allowed stratified analyses to be performed for total cases per capita to gain extra insight into the uncertainty in current practice among esophageal surgeons. By its nature, this survey will have limitations. First, despite widely advertising this survey via multiple specialist organizations and social media, it is possible that selection bias has occurred. Our survey was specifically designed for surgeons and as such the thoughts of patients, oncologists or other healthcare professionals involved in the treatment of esophagogastric surgery have not been elicited. Second, this study did not collect specific patient outcomes for esophageal and gastric cancers surgery and COVID-19. However, research from collaborative groups such as CovidSurg<sup>33</sup> and PanSurg<sup>34</sup> collaborative will provide real-time data to further supplement data from this survey. Finally, this study attempted to stratify current practices by total confirmed cases per capita, but this is likely limited by testing rates available in each country.

### CONCLUSION

In summary, this survey highlights the management challenges and several practice variations in caring for patients with esophagogastric cancers. Dissemination of data from this survey will improve understanding of current international clinical practice during the COVID-19 pandemic. Further, this study has identified the need for clear, consistent national or international guidelines to be in place in the event of a further pandemic to ensure a standardized level of oncological care for patients with esophagogastric cancers.

### Supplementary data

Supplementary data mentioned in the text are available to subscribers in *DOTESO* online.

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