



# Impact of the first surge of the coronavirus disease pandemic on general thoracic surgery practices in Kanagawa: a questionnaire survey by the Kanagawa General Thoracic Surgical Study Group

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## Abstract

**Objectives** The first surge in severe acute respiratory syndrome coronavirus 2 infection had a significant impact on health care institutions. Understanding how the pandemic affected general thoracic surgery would provide valuable data for establishing a health care protocol for upcoming surges.

**Methods** A questionnaire survey on coronavirus disease-related patient statistics and health care was conducted between February 2020 and June 2020 across 14 facilities affiliated with the Kanagawa General Thoracic Surgery Study Group.

**Results** The average number of newly referred patients from February to June 2020 was 65% of that during the same period in 2019. Six facilities placed restrictions on medical care services, among which four restricted surgeries. At all institutions and those placed on surgical restriction, the total number of surgeries under general anesthesia was 92% and 78%, the total number of primary lung cancers was 94% and 86%, and the total number of surgeries for pneumothorax was 71% and 77% of that in the preceding year, respectively. Infection control and insufficient resources of the medical material were the most influential factors impacting the medical institutions' decision to restrict the services provided.

**Conclusions** Restrictions on surgery had a significant impact on the care provided by general thoracic surgery departments. To avoid patient inconvenience, establishing a collaborative system that refers patients to operational medical institutions in case of medical treatment restrictions may be useful.

**Keywords** COVID-19 · First surge · Medical treatment restrictions · Thoracic surgery · Questionnaire survey

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## Introduction

The global spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the resulting coronavirus disease (COVID-19) pandemic had rapidly escalated into a critical situation for healthcare systems worldwide [1]. The first surge of COVID-19 from March to May 2020 and the unprecedented pandemic forced several medical institutions in Japan to restrict routine and conventional health care services and required medical staff to provide maximum effort toward preventing delayed treatment or unavailability of regular medical care to their patients. Kanagawa Prefecture, home to Yokohama Port where the cruise ship *Diamond Princess* docked on February 3, 2020, had been one of the first regions in Japan to provide primary care for passengers, many of whom were infected. Despite the need to provide urgent care for patients with confirmed or suspected COVID-19, concerns regarding the continuity of services for patients requiring treatment for other diseases had emerged.

Considering that general thoracic surgery involves the management of serious diseases, such as lung cancer, mediastinal and chest wall diseases, pulmonary infection, and pneumothorax, which often require hospitalization, restrictions on the treatment of these conditions can negatively influence disease progression and prognosis. Therefore, the provision of adequate care for patients with thoracic surgical conditions, even during the COVID-19 pandemic, is a clinical and ethical necessity [2]. The current regional survey aimed to obtain insights into the establishment and implementation of new medical service systems at various facilities considering the currently ongoing pandemic. Given that the COVID-19 affected Kanagawa earlier and to a larger extent compared to most other parts of Japan, sharing our experiences may help thoracic surgeons tailor their responses to the challenges posed by COVID-19 in upcoming surges. Additionally, we present a status report following the first surge of COVID-19 in Japan.

## Materials and methods

The survey (Supplement 1), which was created by the executive members of the Kanagawa General Thoracic Surgical Study Group (KGTSG), was sent by email on August 1, 2020 to all chief surgeons of the departments of general thoracic surgery at the following 14 facilities affiliated with the KGTSG: Showa University Northern Yokohama Hospital, St. Marianna University School of Medicine, Kanagawa Cancer Center, Kanagawa Cardiovascular

and Respiratory Center, Kawasaki Municipal Hospital, Kitasato University, Keiyu Hospital, Teikyo University Hospital, Mizonokuchi, Tokai University Hospital, Nippon Medical School Musashikosugi Hospital, Yokohama City University Hospital, Yokohama City University Medical Center, Yokosuka Kyosai Hospital, and Yokohama Rosai Hospital. Among the mentioned facilities, 12 and 2 are located in the eastern and western part of Kanagawa Prefecture, respectively. Responses were obtained at the end of August 2020. The Japanese questionnaire comprised the following six sections: (1) medical institution; (2) restrictions on medical services from February 2020 to June 2020; (3) statistical data on patients and medical services from February 2020 to June 2020; (4) operating room conditions from February 2020 to June 2020; (5) practicum and training of interns and residents from February 2020 to June 2020; and (6) improvements in operational facilities based on reflections following the first surge. Information on surgeries in July and August was also collected to confirm the situation after the first wave subsided.

Responses obtained from the questionnaire survey were then analyzed to determine the number of newly referred patients and surgeries from February to June 2020 and compare them to those for the same period in 2019. The Wilcoxon test was used for comparisons between two groups. This study was approved by the Ethics Committee of Showa University Northern Yokohama Hospital (Reference number 21H007).

## Results

### Section 1: medical institution

Valid responses were received from 13 facilities, 10 (76.9%) of which admitted individuals with COVID-19. Extracorporeal membrane oxygenation was available in eight facilities, but only two performed the same.

Thoracic surgeons or general thoracic surgery departments in any of the facilities were not engaged in the front-line management of COVID-19. However, 9 (69.2%) facilities supported the team treating patients with COVID-19 in their care. Some of the roles of general thoracic surgeons in severe cases of COVID-19 included performing tracheotomy, thoracic drainage, ventilator management, and other specialized thoracic surgical treatments and procedures.

As early as August 2020, 3 (23.1%) facilities started performing reverse transcriptase polymerase chain reaction (PCR) tests on all patients scheduled for hospitalization for purposes other than elective surgery. Moreover, 9 (69.2%) facilities screened patients scheduled for general thoracic surgery, while 3 (23.1%) screened patients in departments

other than the general thoracic surgery department. Only one facility did not conduct prehospitalization screening.

**Section 2: restrictions on medical services**

Valid responses were received from 13 facilities, among which 6 (46.2%) placed restrictions on medical care services, whereas 4 (30.8%) had restrictions placed on surgeries. Some factors influencing medical institutions’ decisions to place restrictions on services other than surgery included decreasing the risk of infection in visiting patients, lack of materials, and suggestions from academic societies (such as triage of surgical cases). On the other hand, some

factors influencing decisions to place restrictions on surgeries included the lack of beds for postoperative management due to allocation for infection control, lack of materials, and suggestions from academic societies. The requests of medical staff, such as physicians and paramedical staff, had little effect on the medical institutions’ decisions to restrict surgeries and other medical services (Table 1).

**Section 3: statistics on patients and medical services**

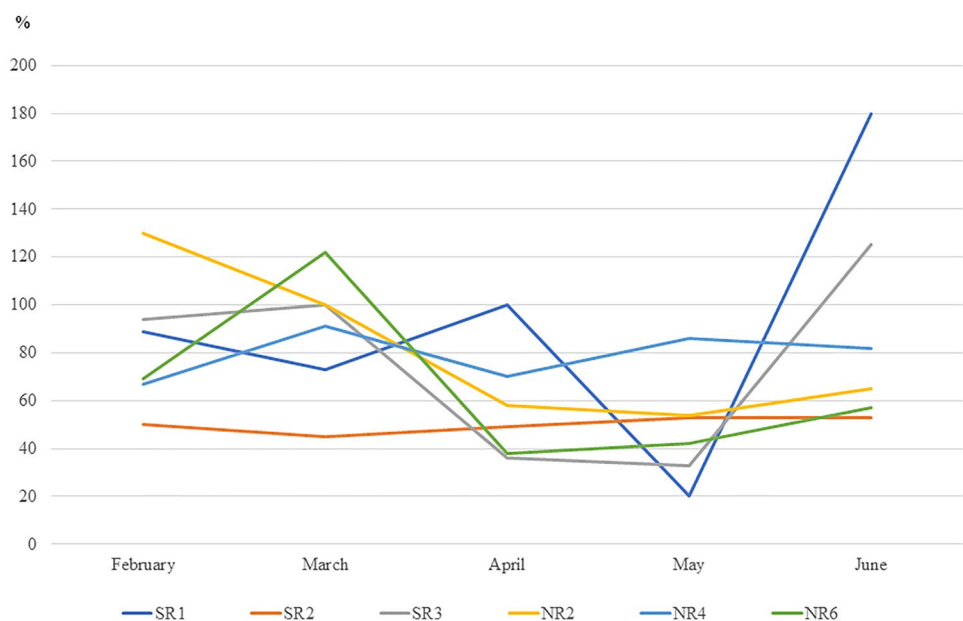
Six facilities provided valid responses related to the number of referred patients. As shown in Fig. 1, the number of referred patients was lower in April and May 2020 than in

**Table 1** Factors that influenced the decision on restrictions on medical services

Factors for restrictions on medical care other than surgery	Average score <sup>a</sup>
Measures to reduce the risk of infection in visiting patients	3.6
Lack of infection control materials	3.4
Recommendations from each academic society	3.2
Reduction of medical care space	3
Requests from doctors in each department	2
Requests from co-medical staff, including clerks	2
Factors for surgical restrictions	Average score <sup>a</sup>
Reduction of beds for postoperative management	4
Lack of infection control materials	3
Recommendations from each academic society	3
Requests from comedic staff, such as surgical nurses	1.8
Request from anesthesiologists	1.3
Requests from doctors in each department	1.3

<sup>a</sup>Each factor was evaluated from 1 to 5 points; 1 point was given when there was no effect, and 5 points were given when the effect was sufficient

**Fig. 1** Percentage of referred patients from February 2020 to June 2020 compared to that in the corresponding months in 2019. SR, facilities with restrictions on surgery; NR, facilities without restrictions on medical services



the same months in 2019. At each institution, the average number of newly referred patients was 65% of that in the preceding year.

A total of 12 facilities provided surgeries under general anesthesia in the department of general thoracic surgery, whereas 11 performed surgeries based on the type of surgery. The total number of surgeries under general anesthesia at all institutions was 92% of that in the preceding year. All surgeries under general anesthesia at all institutions showed a declining trend toward June, at the end of the first surge (Fig. 2). The rates of surgery under general anesthesia did not significantly differ between hospitals with  $\geq 500$  and  $< 500$  beds ( $p=0.6847$ ) and between facilities with and without restrictions on surgery ( $p=0.0522$ ) (Fig. 3A, B). However, among institutions that restricted surgeries (SR1, SR2, and SR3; SR, facilities with restrictions on surgery), the total number of surgeries under general anesthesia was 78% of that in the preceding year. In facility SR1, which was the most affected, the total number of surgeries was only 62% of that in 2019 and decreased the most to 21% by May 2020. Notably, no nosocomial infections or clusters occurred in facility SR1 (Fig. 4).

The total number of primary lung cancers at all institutions was 94% of that in the preceding year, with the rate of primary lung cancers showing a declining trend toward June, at the end of the first surge (Fig. 2). No significant differences in primary lung cancer rates were observed between hospitals with  $\geq 500$  and  $< 500$  beds ( $p=0.4652$ ) and between facilities with and without restrictions on surgery ( $p=0.2207$ ) (Fig. 3C, D). At institutions that restricted surgeries (SR1, SR2, and SR3), the total number of primary lung cancers was 86% of that in the preceding year. Although NR1, NR5, and NR6 (NR: facilities without restrictions on

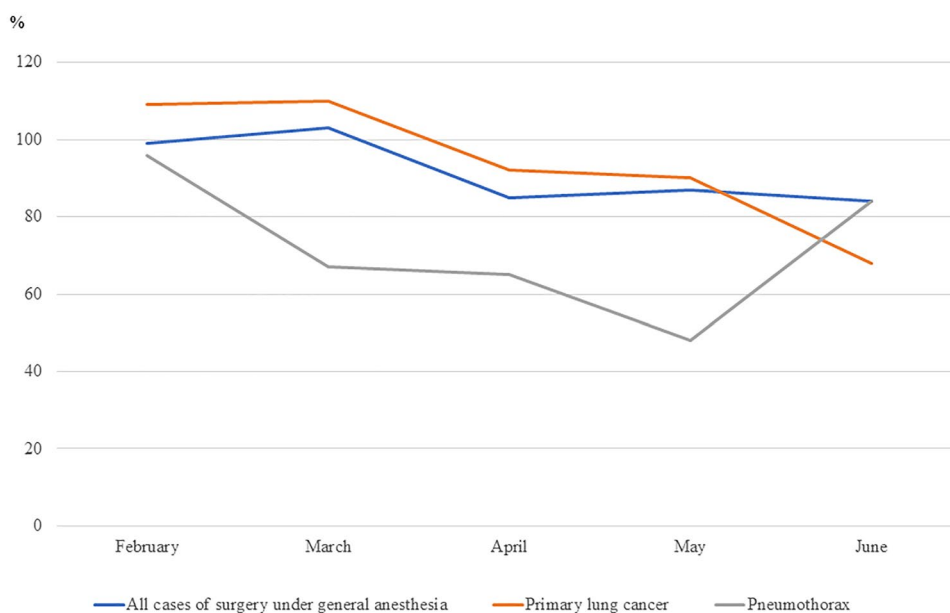
medical services) did not implement strict medical restrictions, surgeries for primary lung cancer were  $\leq 90\%$  of that in the preceding year. Although primary lung cancer staging was not investigated, surgery was not postponed or discontinued for advanced cases.

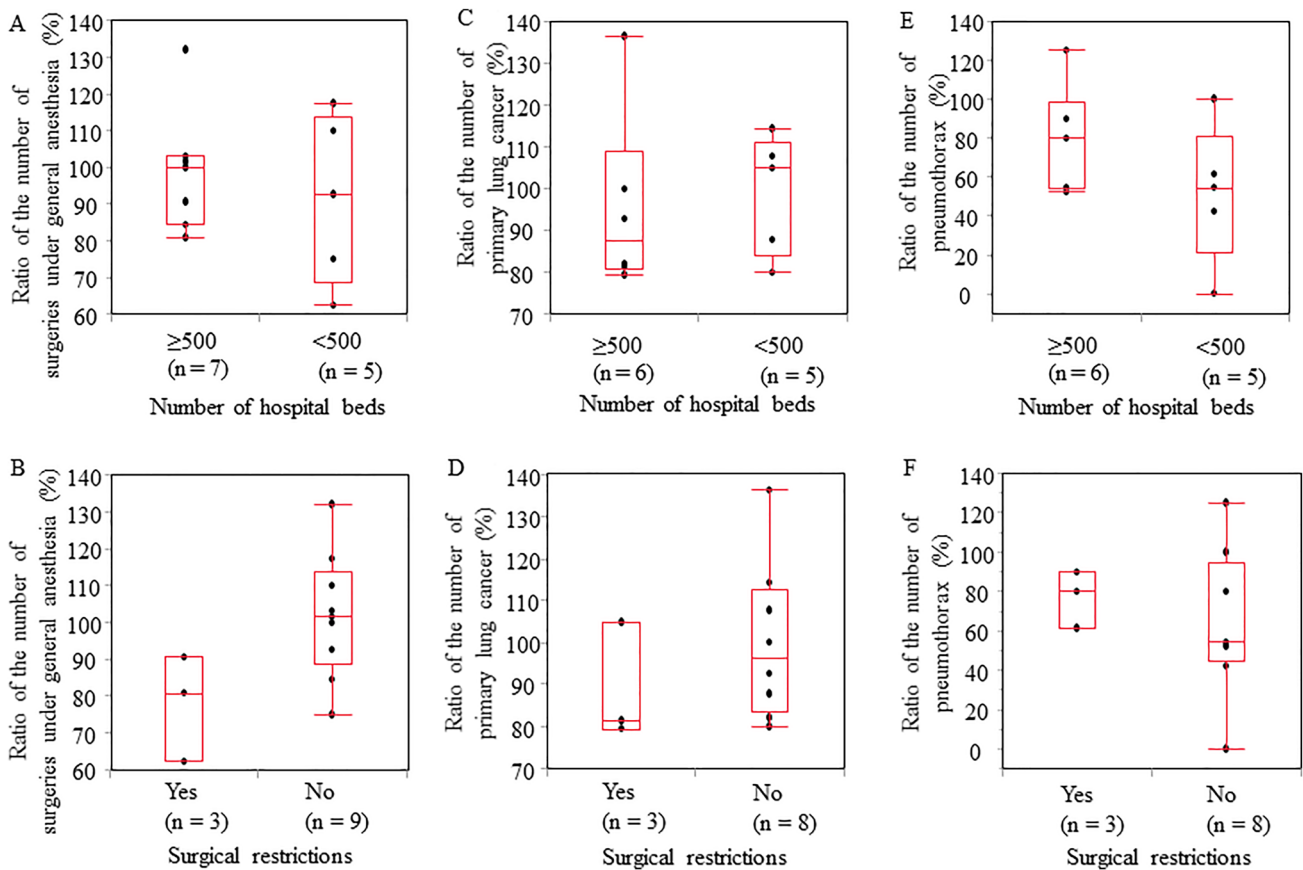
The total number of pneumothorax cases at all institutions was 71% of that in the preceding year. The rate of pneumothorax at all institutions showed a decline, with the lowest being in May under the state of emergency (Fig. 2). No significant differences in pneumothorax rates were observed between hospitals with  $\geq 500$  and  $< 500$  beds ( $p=0.2332$ ) and between facilities with and without restrictions on surgery ( $p=0.3561$ ) (Fig. 3E, F). Among the institutions that restricted surgeries (SR1, SR2, and SR3), the total number of pneumothorax cases was 77% of that in the preceding year. The number of surgeries for pneumothorax was  $\leq 90\%$  of that in the preceding year in 9 (81.8%) facilities, including institutions that restricted surgeries. Although facility NR1 did not implement strict medical restrictions, no surgery for pneumothorax was performed (Fig. 4).

An additional survey was conducted to determine trends in the number of surgeries after the first wave, to which nine facilities responded. As of August 31st, the total number of surgeries under general anesthesia, primary lung cancers, and pneumothorax was 80%, 90%, and 59% of that in the preceding year, respectively (Supplement 2).

A total of 12 facilities provided valid responses regarding surgeries for patients with suspected and confirmed COVID-19. The departments of general surgery, including general thoracic surgery, of 4 (33.3%) facilities performed surgeries on patients with suspected and confirmed COVID-19 from February 2020 to June 2020, including cesarean section, ureteral stent placement, surgery for paranasal

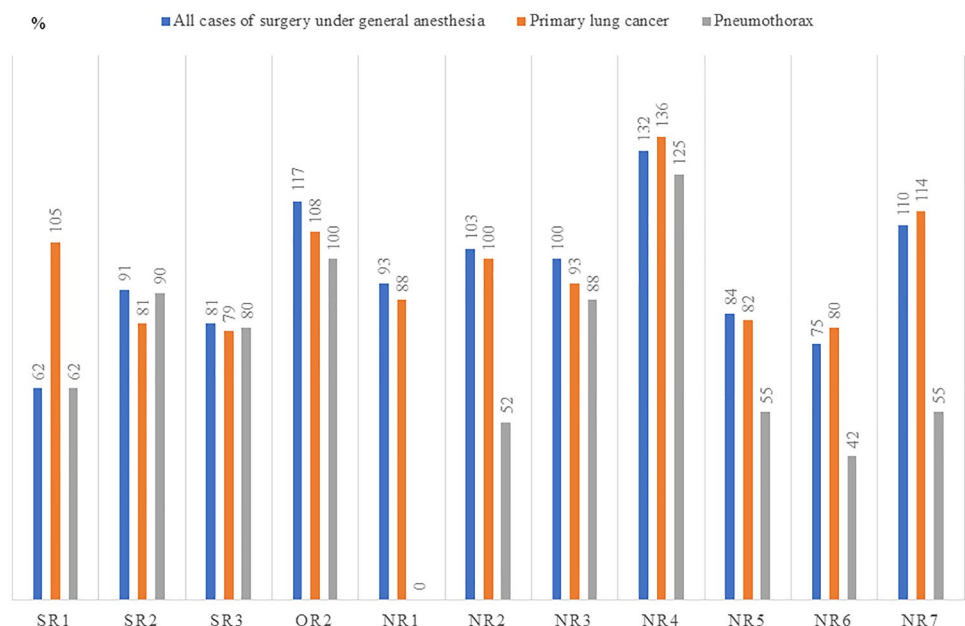
**Fig. 2** Percentage of all cases with surgery under general anesthesia, primary lung cancer, and pneumothorax referred from February 2020 to June 2020 compared to that in the corresponding months in 2019





**Fig. 3** Relationship between the number of surgeries under general anesthesia and primary lung cancer and pneumothorax in 2020 and 2019 and the number of general beds or surgical restrictions at the facility

**Fig. 4** Percentage of surgeries from February 2020 to June 2020 compared to that in the corresponding months in 2019. SR, facilities with restrictions on surgery; OR, facilities with restrictions on procedures other than surgery; NR, facilities without restrictions on medical services





sinusitis, gastrointestinal perforation, cholecystitis, mediastinal abscess, and pneumothorax, subcutaneous implantation of a cardioverter defibrillator, and tracheostomy. Among the four mentioned facilities, two achieved adequate infection control measures, whereas the other two did not. The lack of adequate infection control measures was attributed to delays in creating intrahospital guidelines and allocating surgery rooms equipped with infection control measures. Although general thoracic surgeries under general anesthesia were not performed on any patient with confirmed COVID-19, they were performed on two patients with suspected COVID-19. Accordingly, one patient with mediastinal abscess and another with pneumothorax underwent surgery at two different facilities, both of whom were postoperatively confirmed to be negative for COVID-19.

#### **Section 4: operating rooms conditions**

Valid responses were received from 13 facilities. Among such facilities, 5 (38.5%) expressed the lack of materials, such as surgical gloves, masks, gowns, and goggles. Moreover, 7 (53.8%) implemented infection control measures to protect against potential asymptomatic carriers of the virus; 5 (38.5%) decreased the number of staff in the operating room; and 3 (23.1%) implemented measures to manage surgical smoke.

#### **Section 5: practicum and training of interns and residents**

Valid responses were received from 12 facilities. Accordingly, 4 (33.3%) facilities offered practicums for students between February 2020 and June 2020, whereas all facilities offered internships and residencies. Notably, the facilities implemented their own measures to prevent interns from being involved in COVID-19-related services. All programs achieved the target number of surgeries in terms of their effects on residency programs.

#### **Section 6: improvements in operational facilities based on reflections following the first surge**

Regarding improvements in the surgical system within facilities influenced by the first surge, several respondents highlighted the importance of securing the inventory of materials after the first wave. Moreover, they suggested increasing the number of beds in negative-pressure rooms among other forms of infection control measures, increasing the number of rooms for handling specimens, prompting preparation of inpatient hospital guidelines, and implementing stringent screening with PCR and other methods for patients upon admission.

## **Discussion**

The COVID-19 pandemic has overwhelmingly impacted routine clinical care. Arguably, the impact on the prognoses of diseases requiring general thoracic surgery, including malignancies (e.g., lung cancer) and infectious diseases (e.g., empyema and pneumothorax), can be considered the most significant given that the successful management of these diseases is time dependent. Therefore, accumulating data on the impact of the COVID-19 pandemic on general thoracic surgical care, including problems encountered and their extent, are important and will provide knowledge that would guide the establishment of future measures to address the ongoing pandemic. Thus, the KGTSG conducted the present survey on medical institutions across Kanagawa Prefecture.

Our findings showed that six facilities placed restrictions on medical care services, with four placing restrictions on surgeries. Surgical gowns, gloves, and masks were used as personal protective equipment, causing a shortage in infection control supplies and restrictions on medical care. The subsequent increase in the number of infections and declaration of a state of emergency prevented potential patients from undergoing medical examinations and visiting medical institutions. According to the Japan Society of Health Evaluation and Promotion, 75% of medical examination institutions were completely or partially suspended under the declaration of a state of emergency [3]. The aforementioned factors promoted a decrease in the number of newly referred patients and those who underwent surgical treatment, which was confirmed in our survey. Therefore, a significant decrease in the number of surgeries was apparent in facilities that implemented restrictions on surgery, although some facilities were hardly affected. Statistically, the number of beds and restrictions on surgery did not affect the number of surgeries. Considering that only few facilities were evaluated, no clear impact could be observed. However, if the number of beds was small and the surgical treatment was restricted, the impact could have been significant and the number of surgeries may have decreased.

Given that delaying treatment can negatively impact the prognosis of primary lung cancer, an aggressive malignant tumor, [4, 5], timely treatment is needed. However, our findings showed that the number of primary lung cancer surgeries was 86% of that in the previous year at facilities that restricted surgeries. The proportion of lung cancer stages in lung cancer surgery cases was assumed to have changed because of the effects of the pandemic and surgical coordination at each institution. Although the current survey did not investigate the proportion of patients with each lung cancer stage at each institution, surgery was

not postponed for advanced cases. Notably, one significant finding of this survey is change in the staging rate of surgical cases in 2020 considering that as Japan's National Cancer Registry data for 2020 would normally be reported 2 years later. Therefore, disclosure of this registry data might allow us to assess the changes in the prognosis of patients with lung cancer caused by the pandemic. In Italy, for instance, where extensive lockdown measures were implemented, a decreased number of visits, postponement of surgery, and decreased number of surgeries were observed in patients with primary lung cancer who had been originally indicated for surgery [6]. At present, Japan has a lower number of infected patients compared to several other countries. However, Japan may face a medical crisis equal to or worse than that faced by Italy if the infection spreads. Therefore, measures to maximize the use of limited medical facilities and resources are essential to continue providing care with minimal inconvenience to patients. For example, surgery restrictions may be enforced without sufficient time for preparation. In such a situation, a collaborative system that refers patients to medical institutions that have not restricted surgical procedure or those that are less affected by the spread of infection may be useful.

Several medical institutions included in this survey showed a decrease in the number of surgeries for pneumothorax. This decrease could be associated with the recommendations of various medical associations, including the Japanese Surgical Society, regarding the priority of surgical care. The joint statement by the Japanese Medical Science Federation and 13 surgical societies (the Japan Surgical Society, the Japanese Society of Gastroenterological Surgery, The Association for Thoracic Surgery, the Japanese Society for Cardiovascular Surgery, the Japanese Society for Vascular Surgery, the Japanese Association for Chest Surgery, the Japanese Society of Pediatric Surgeons, the Japanese Breast Cancer Society, the Association of Endocrine Surgery, the Japan Society for Endoscopic Surgery Society, the Japanese Orthopedic Association, and the Japanese Urological Association) emphasized the need for ensuring the safety of both patients and medical staff for the continuation of medical activities. Patient triage before surgery becomes indispensable when medical resources are limited. Moreover, conservative therapy or surgeries not requiring general anesthesia might be considered. Furthermore, restrictions on social activities following the declaration of a state of emergency may have decreased the incidence of pneumothorax. To the best of our knowledge, however, no existing studies have investigated the relationship between social activities and the incidence of pneumothorax. However, we should note that pneumothorax has been putatively linked to pulmonary disorders and positive-pressure ventilator management for COVID-19 and has been reported to be a complication

of COVID-19 [7]. Patients with COVID-19 and pneumothorax need specialized pneumothorax treatment by thoracic surgeons. Moreover, the detection of SARS-CoV-2 RNA in pleural fluid requires measures to prevent aerosolization of the virus during thoracic drainage and management [8, 9].

Over the course of the COVID-19 pandemic, several critically ill patients had required mechanical ventilation. The requirement for relatively prolonged ventilation in survivors suggests that several patients will be considered for tracheostomy to facilitate weaning off ventilatory support and maximize scarce resources. However, tracheostomy places health care workers at high risk for the transmission of acute respiratory infections [10]. According to the present survey, tracheostomy was performed on patients with confirmed or suspected COVID-19, which requires highly experienced and skilled surgeons. Therefore, thoracic surgeons should have adequate knowledge and training on post-tracheostomy management in addition to performing simulations of tracheostomies in the context of the pandemic. However, no evidence has yet suggested that tracheostomy improves the clinical course of patients with COVID-19 [11, 12].

Smoke from surgical energy devices also contains various particles, including viruses and carcinogenic substances. Although the risk of infection via this smoke has not been adequately studied [13], the Japanese Surgical Society had proposed the use of smoke extractor devices for surgery during the COVID-19 pandemic, with the assumption that the smoke can contain SARS-CoV-2. Notably, our survey found that only 23.1% of the facilities had taken specific measures for the management of smoke generated during surgery.

This study has several limitations worth noting. First, this survey included only facilities affiliated with the KGTSG, which included the main medical institutions in Kanagawa Prefecture. The list of facilities presented herein is not a complete list of medical institutions that have general thoracic surgery departments and does not cover practice throughout Kanagawa Prefecture. Although regional differences in the spread of infection between the eastern and western parts of Kanagawa Prefecture can be assumed, they remained unknown in this study. Second, the questions were answered freely at the discretion of individual respondents. Third, given that clinical research procedures were not performed, concerns related to the accuracy of the answers were inevitable. Tracking individual cases is difficult. However, allowing respondents to ignore items they found difficult to answer may have resulted in some bias.

## Conclusion

This survey summarized the impact of the first surge of the COVID-19 pandemic on general thoracic surgical care in various medical institutions across Kanagawa, Japan. During

a pandemic, medical treatment may be restricted due to the patient's or medical institution's circumstances. This takes away the opportunity to treat patients who would otherwise be indicated for treatment. Moreover, surgical restrictions can lead to loss of opportunity for surgical treatment. Given the limited modifications available at the medical institution level, it is essential to secure sufficient materials to overcome these disadvantages. Additionally, it may be useful to establish a collaborative system that refers patients to operational medical institutions when their institution decides to restrict medical treatment.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s11748-021-01724-z>.

## Declarations

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

## References

1. Data from Johns Hopkins University (JHU). Available at: <https://coronavirus.jhu.edu/map.html>. Accessed 29 July 2021.
2. Calabrò L, Peters S, Soria JC, Di Giacomo AM, Barlesi F, Covre A, et al. Challenges in lung cancer therapy during the COVID-19 pandemic. *Lancet Respir Med*. 2020;8:542–4.
3. Japan Society of Health Evaluation and Promotion, National Federation of Industrial Health Organization. Survey report on the impact of the spread of the new corona infection on medical examination institutions. *Health Eval Promot*. 2021;48:105–9. <https://doi.org/10.7143/jhep.48.105> (published in Japanese).
4. Tsai CH, Kung PT, Kuo WY, Tsai WC. Effect of time interval from diagnosis to treatment for non-small cell lung cancer on survival: a national cohort study in Taiwan. *BMJ Open*. 2020. <https://doi.org/10.1136/bmjopen-2019-034351>.
5. Maringe C, Spicer J, Morris M, Purushotham A, Nolte E, Sullivan R, et al. The impact of the COVID-19 pandemic on cancer deaths due to delays in diagnosis in England, UK: a national, population-based, modelling study. *Lancet Oncol*. 2020;21:1023–34.
6. Viggiano D, Lococo F, Dell'Amore A, Crisci R, Torre M, Rea F, et al. Hospital organization and thoracic oncological patient management during the coronavirus disease-2019 outbreak: a brief report from a nationwide survey of the Italian Society of Thoracic Surgery. *Interact Cardiovasc Thorac Surg*. 2020;31:895–9.
7. Martinelli AW, Ingle T, Newman J, Nadeem I, Jackson K, Lane ND, et al. COVID-19 and pneumothorax: a multicentre retrospective case series. *Eur Respir J*. 2020. <https://doi.org/10.1183/13993003.02697-2020>.
8. Schaller T, Hirschtbühl K, Burkhardt K, Braun G, Trepel M, Markl B, et al. Postmortem examination of patients with COVID-19. *JAMA*. 2020;323:2518–20.
9. Pieracci FM, Burlow CC, Spain D, Livingston DH, Bulger EM, Davis KA, et al. Tube thoracostomy during the COVID-19 pandemic: guidance and recommendations from the AAST Acute Care Surgery and Critical Care Committees. *Trauma Surg Acute Care Open*. 2020. <https://doi.org/10.1136/tsaco-2020-000498>.
10. Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. *PLoS One*. 2012. <https://doi.org/10.1371/journal.pone.0035797>.
11. McGrath BA, Brenner MJ, Warrillow SJ, Pandian V, Arora A, Cameron TS, et al. Tracheostomy in the COVID-19 era: global and multidisciplinary guidance. *Lancet Respir Med*. 2020;8:717–25.
12. McGrath BA, Brenner MJ, Warrillow SJ. Tracheostomy for COVID-19: business as usual? *Br J Anaesth*. 2020;125:867–71.
13. Mowbray NG, Ansell J, Horwood J, Cornish J, Rizkallah P, Parker A, et al. Safe management of surgical smoke in the age of COVID-19. *Br J Surg*. 2020;107:1406–13.

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