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The Korean Society for Neuro-Oncology (KSNO) Guideline for the Management of Brain Tumor Patients During the Crisis Period: A Consensus Recommendation Using the Delphi Method (Version 2023.1)

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Background During the coronavirus disease 2019 (COVID-19) pandemic, the need for appropriate treatment guidelines for patients with brain tumors was indispensable due to the lack and limitations of medical resources. Thus, the Korean Society for Neuro-Oncology (KSNO), a multidisciplinary academic society, has undertaken efforts to develop a guideline that is tailored to the domestic situation and that can be used in similar crisis situations in the future.

Methods The KSNO Guideline Working Group was composed of 22 multidisciplinary experts on neuro-oncology in Korea. In order to reach consensus among the experts, the Delphi method was used to build up the final recommendations.

Results All participating experts completed the series of surveys, and the results of final survey were used to draft the current consensus recommendations. Priority levels of surgery and radiotherapy during crises were proposed using appropriate time window-based criteria for management outcome. The highest priority for surgery is assigned to patients who are life-threatening or have a risk of significant impact on a patient's prognosis unless immediate intervention is given within 24–48 hours.

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As for the radiotherapy, patients who are at risk of compromising their overall survival or neurological status within 4–6 weeks are assigned to the highest priority. Curative-intent chemotherapy has the highest priority, followed by neoadjuvant/adjuvant and palliative chemotherapy during a crisis period. Telemedicine should be actively considered as a management tool for brain tumor patients during the mass infection crises such as the COVID-19 pandemic.

Conclusion It is crucial that adequate medical care for patients with brain tumors is maintained and provided, even during times of crisis. This guideline will serve as a valuable resource, assisting in the delivery of treatment to brain tumor patients in the event of any future crisis.

Keywords Korean Society for Neuro-Oncology; Guideline; Brain tumors; Crisis; Delphi.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic, which began at the end of 2019, has become an unprecedented, prolonged global event. The healthcare system faced numerous crises that posed a threat of overwhelming the existing medical systems. This resulted in a sudden surge in demand for COVID-19 treatments, shortage of medical resources, and a temporary disruption in providing care to patients with other ailments. Brain tumor patients were not immune to these challenges, and healthcare professionals found it challenging to provide adequate management given the limited resources available. However, providing effective management for patients during a crisis can be challenging in the absence of proper guidelines.

Several leading international medical associations in the field of neuro-oncology have proposed guidelines for the management of brain tumor patients during the COVID-19 pandemic [1-3]. The American Association of Neurological Surgeons (AANS)/Congress of Neurological Surgeons (CNS) Tumor Section and the Society for Neuro-Oncology (SNO) released general treatment guidelines for prioritizing inpatient and outpatient cases during the pandemic in 2020 [2]. Likewise, the neuro-oncology community in the UK also presented guidelines for the management of neuro-oncology patients during this period [3]. However, these guidelines have limitations in their applicability in Korea due to the uniqueness of the domestic medical environment.

In response to this, the Korean Society for Neuro-Oncology (KSNO), a multidisciplinary academic society, developed specialized clinical guidelines for the management of brain tumor patients in the domestic medical environment during a crisis. The aim of this project was to develop comprehensive guidelines that can be applied universally to various situations that may cause a scarcity of medical resources, not limited to the COVID-19 pandemic. In this guideline, a crisis period is defined as a situation in which medical resources for managing brain tumor patients are limited due to various causes such as natural disasters, mass infection crisis, and wars, making it impossible to proceed with usual management. The guideline addresses the selection of treatment priorities, including surgery, radiotherapy, chemotherapy, clinical trials, radiographic surveillance, and telemedicine, for managing brain tumor patients during the crisis period.

METHODS

This guideline concerns the management of brain tumor patients during crisis situations where there is insufficient evidence available. To address these issues, the Delphi technique was employed. This method involves gathering and synthesizing the expert opinions through multiple rounds of surveys and summarizing them as a collective decision. The Delphi process is a proven and validated method for achieving consensus within medical groups [4,5]. The Delphi process employed in this guideline is detailed in Fig. 1.

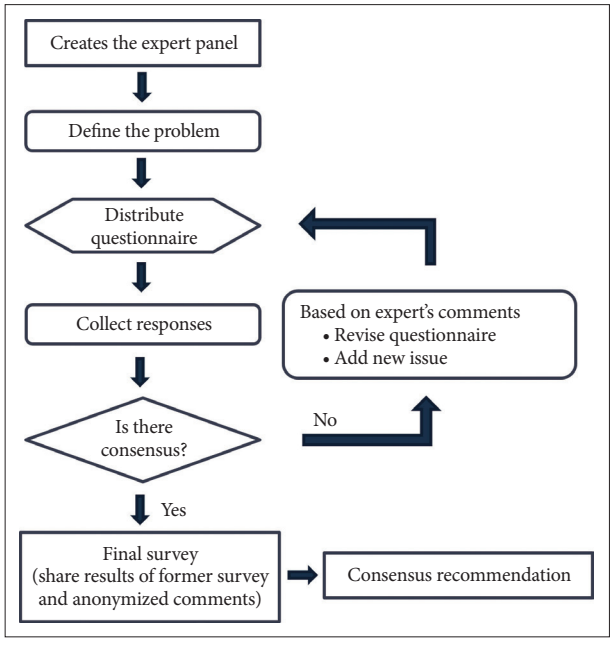

Fig. 1. Flow chart of the Delphi process employed in the guideline.

The expert group comprised 22 multidisciplinary members of the KSNO Guideline Working Group, consisting of 16 neurosurgeons, 4 radiation oncologists, 1 medical oncologist, and 1 pathologist. They undertook a review of various guidelines related to the management of brain tumor patients during crisis situations, primarily the COVID-19 pandemic, and identified the issues to be addressed in this guideline. Subsequently, a questionnaire was formulated for each round of surveys, and experts were requested to provide comments for each question explaining their responses. Three rounds of surveys were conducted between June and August 2022, and the questionnaire was modified and expanded based on the results of each preceding round.

A final survey was conducted in October 2022 consisting of seven categories: treatment priority, pathology, surgery, radiotherapy, chemotherapy and clinical trial, radiological surveillance, and telemedicine. The survey included 39 questions (Supplementary Material in the online-only Data Supplement). Feedback from the previous rounds was provided to the experts during the final survey, allowing them to consider the views of their peers and revise their original responses. To ensure that no one expert's opinion dominated the consensus, responses were submitted anonymously. The entire survey process was conducted remotely using Google Forms (https://forms.google.com/). The results of the final survey were used to draft the current consensus recommendations. Consensus was defined as an agreement level of 50% or higher among the panel of experts [5]. A consensus statement was considered "recommended" for clinical practice when agreement reached 50%–74%, and "highly recommended" when agreement reached 75% or higher. No confidential or patient information was used in the survey, and ethics committee approval was not deemed necessary, as is typical in Delphi method studies conducted in the medical field [6].

RESULTS

All participating experts completed the final survey process. The results of the survey for each question are presented in the Supplementary Material (in the online-only Data Supplement).

General treatment priority

When determining treatment priority for brain tumor patients during crisis periods, it is crucial to consider various factors such as the presence or absence of acute neurological deterioration with symptoms of increased intracranial pressure (IICP), the progression rate of the tumor, the possibility of neurological improvement following treatment, the long-term prognosis after treatment, the patient's age, and underlying medical conditions. Expert panels suggest that the presence or absence of acute neurological deterioration with IICP symptoms is the most significant factor in determining treatment priority, with 85.7% of the panel in agreement. Furthermore, 71.4% of expert panels agreed that, in cases where other factors are similar, a newly diagnosed case should receive higher priority during a crisis period than a recurrent case. All expert panels agreed that treatment priority for cases with a very poor prognosis, even with prompt treatment, can be postponed to allocate medical resources effectively during the crisis period. However, it is essential to consult adequately with the patient and their caregiver before making any decisions.

Surgery

During the crisis period for brain tumor patients, a vast majority of expert panels (95.2%) have agreed on the surgical priority level based on the "time window-based criteria." It has also been widely agreed (95.2%) that reassessment of surgical priority should be done regularly, considering factors such as the severity of neurological symptoms, availability of medical resources, and the possibility of adjuvant treatment after surgery. The recommended levels of surgical priority are detailed in Table 1. However, consensus has not been reached among expert panels regarding whether benign tumors, with a relatively better long-term prognosis than malignant tumors, should be given surgical priority during the crisis period. While some experts (52.4%) have agreed that the extent of tumor resection for malignant tumors can be reduced to effectively allocate limited medical resources, there are substantial opposing opinions (42.9%). Finally, a significant majority of expert panels (90.5%) have agreed that surgical intervention for brain tumor patients with a legally communicable disease, such as COVID-19, should only be carried out on patients classified as surgical priority A. Surgery for patients with lower surgical priority should be postponed until the quarantine period has ended.

Pathology

In terms of pathology examination, a particular matter was scrutinized. A significant majority of experts (95.2%) agreed that a treatment plan could be developed based on conventional histological diagnoses alone, without molecular genetic information, especially during the crisis period for diagnosing World Health Organization (WHO) 2021 diffuse glioma.

Radiotherapy

Radiotherapy is an essential treatment modality in neuro-oncology. Therefore, during times of crisis such as outbreaks of infectious diseases (e.g., COVID-19) or natural disasters which can cause shortage of medical resources, ensuring efficient distribution of radiotherapy resources including medi-

cal staff, space, equipment availability, is crucial. Furthermore, for high-risk patients vulnerable to infectious diseases, reducing the visit to radiotherapy facilities is essential. In this study, we conducted a survey to reach a consensus among Korean neuro-oncologists on the issues described below.

Prioritizing radiotherapy during the crisis

In order to provide guidance to physicians during periods of crisis, where there may be a shortage of medical resources, expert panels have established a consensus on how to prioritize patients in need of radiotherapy. Specifically, the panels were asked to consider whether a simple "time window-based criteria" or a "disease-specific clinical scenario-based criteria" would be more appropriate for prioritization purposes. Out of the 21 respondents, 85.7% recommended that patients be prioritized based on treatment time window and prognosis, as detailed in Table 2.

Radiotherapy dose-fractionation for patients with high-grade gliomas during the crisis

An expert panel was consulted to determine whether hypofractionated radiotherapy could be routinely prioritized over conventionally fractionated radiotherapy in 6 weeks for elderly patients with high-grade gliomas. All 21 respondents (100.0%) agreed that hypofractionated radiotherapy should be preferred for elderly patients during the crisis period. Additionally, respondents commented that hypofractionated radiotherapy should also be preferred for high-grade glioma patients with poor performance or frailty during the crisis.

We also conducted a survey to determine the most preferred hypofractionated radiotherapy regimen for high-grade glioma patients during the crisis. Among the 21 respondents, the most preferred regimen for hypofractionated radiotherapy when medical resources are scarce was "40−45 Gy in 3 weeks" (57.1%). Six respondents (28.6%) suggested that the hypofractionated dose-fractionation schedule should be determined based on the severity of medical resource shortage. This was followed by 34 Gy in 2 weeks (9.5%) and 25−30 Gy in 1 week (4.8%).

Utilization of radiotherapy resource during the crisis

In the survey, expert panels were presented with three options for choosing between hypofractionated and conventionally fractionated radiotherapy for brain tumor patients. These options were: 1) hypofractionated radiotherapy for all brain tumor cases; 2) hypofractionated radiotherapy only for cases where adequate treatment efficacy is expected, or sufficient evidence is published; and 3) conventionally fractionated standard radiotherapy in all cases. Most respondents (76.2%) agreed that hypofractionated short-course radiotherapy can be preferred over conventionally fractionated standard radiotherapy, but only when adequate treatment efficacy is expected or sufficient evidence is published, even in a resource-constrained crisis setting. None of the respondents agreed that conventionally fractionated standard radiotherapy is the preferred dose-fractionation for all cases.

Regarding brain tumor patients who require radiotherapy and have a legally communicable disease such as COVID-19, 81% of expert panels responded that only patients with "priority level A" (Table 2) should be considered for radiotherapy as required. Only 9.5% of respondents agreed to treat patients with "priority level B" (Table 2) as well. Apart from patients with "priority level A," some experts recommended considering radiotherapy in cases such as germinoma or lymphoma where a high response rate can be expected with radiotherapy, and chemotherapy is not feasible due to the shortage of healthcare resources.

Chemotherapy

According to a survey of experts, 85.7% believe that chemo-

Table 1. Proposed surgical priority during the crisis period

Priority level	Description
Priority A	Patients in whom surgery is required immediately or within 24−48 hours because of life-threatening risk or significantly altering the patient's prognosis.
Priority B	Patients for whom a delay of <4 weeks from target would not be anticipated to impact significantly on the patient's prognosis.
Priority C	Patients for whom a delay of 2−3 months would be unlikely to affect the patient's prognosis.

Table 2. Proposed radiotherapy priority during the crisis period

Priority level	Description
Priority A	Cases where compromised overall survival or neurology is expected unless radiotherapy is initiated immediately or within 4−6 weeks.
Priority B	Cases where compromised progression-free survival or local control is expected unless radiotherapy is initiated within 3 months.
Priority C	Cases where radiotherapy is not expected to substantially affect prognosis (e.g., radiotherapy for palliation of mild symptoms).

therapy should be administered when it can significantly improve the patient's prognosis or alleviate tumor-related symptoms. The priority of chemotherapy goals should be curative first, followed by neoadjuvant/adjuvant, and then palliative, according to the majority of respondents. Specifically, 85.7% of the respondents consider neoadjuvant/adjuvant chemotherapy to be a higher priority than palliative chemotherapy. During the crisis period, most experts (85.7%) prefer a chemotherapy regimen that is relatively effective, has low toxicity, and minimizes visits to medical institutions. For non-emergency patients who are unable to receive chemotherapy immediately due to lack of resources, the majority (85.7%) believe that chemotherapy should be postponed for a certain period, with transfer to a medical institution if the problem persists. Finally, the survey found that decisions regarding the chemotherapy regimen for a patient during the crisis period should be made through a multidisciplinary approach or care, according to 52.4% of the respondents.

Clinical trial

The majority of experts (76.2%) advocated for the continuation of ongoing subjects while suspending new subject registration and new clinical trials. A minority of the experts (14.3%) proposed that clinical trials should proceed without restrictions. Only a small percentage (4.8%) suggested that all clinical trials should be suspended during the period of crisis.

Radiological surveillance

In situations where medical resources are limited, such as during the COVID-19 pandemic, it is crucial to establish a routine surveillance interval. Efficient allocation of resources may be more important than prioritizing treatments as mentioned previously. A survey was conducted for each content, and a sufficient consensus was reached.

The modified radiological surveillance schedule during the crisis

The adequate radiological surveillance schedule for patients with a primary malignant brain tumor (e.g., malignant glioma) or brain metastasis after standard treatment during the crisis period was asked according to their disease status such as complete response (CR), partial response (PR), stable disease (SD), and progressive disease (PD).

For primary malignant brain tumors, the majority of respondents (66.7%, 71.4%, and 71.4% for CR, PR, and SD, respectively) recommended extending the follow-up period beyond the existing protocol. Similarly, for cases of brain metastasis, most respondents suggested a longer follow-up period than the current protocol for all response categories (66.7%, 81.0%, and 76.2% for CR, PR, and SD, respectively). Moreover, nearly all respondents (95.2%) concurred with the decision to defer follow-up MRIs for benign brain tumors that do not exhibit any clinical signs of progression.

However, other panel opinions recommended that follow-up MRI should be conducted routinely in certain cases, even in the absence of clinical progression. These include 1) types of tumors known to have high risk of malignant transformation, 2) lesions located near the brainstem or cranial nerve where there is a serious risk of irreversible growth, and 3) tumors with an expected high growth rate.

The feasibility of using an alternative to MRI

When asked whether CT (with or without contrast) can be used as a substitute for MRI, assuming limited resources for MRI, 76.2% of respondents said it is possible to replace it in the case of an extra-axial tumor, while 57.2% said it can be used as a substitute for an intra-axial tumor.

Telemedicine

Due to the COVID-19 outbreak, non-face-to-face treatment have become inevitable, resulting in an increased interest in telemedicine. Telemedicine can be a crucial tool during crises like the COVID-19 pandemic. In this regard, a survey was conducted.

Necessity of telemedicine

All respondents (100%) agreed that telemedicine can be actively considered when treating brain tumor patients in an infectious disease crisis such as the COVID-19 pandemic. Regarding the question of whether telemedicine can serve as a substitute for all clinical situations, most respondents answered affirmatively for patients who have completed standard treatment for malignant brain tumors, as well as patients who have undergone treatment for brain metastasis (such as surgery, stereotactic radiosurgery [SRS], whole brain radiation therapy [WBRT], chemotherapy, or combined treatment). However, respondents noted that telemedicine may not be suitable for cases where the disease status is PD.

Regarding the benign brain tumors, most respondents (90.5%) answered that telemedicine can be used, regardless of whether there is a residual tumor. Additionally, most respondents agreed that telemedicine can be substituted for patient interviews or progress checks during chemotherapy (90.5%) or radiotherapy (95.2%). However, when asked whether telemedicine can be used to treat new patients who need surgery, radiotherapy, or chemotherapy, a significant number of respondents answered that it is not substitutable (71.4%, 66.7%, and 61.9%, respectively).

Platform for telemedicine

In general, telemedicine can be done using video and audio communication equipment between the doctor and the patient. However, many respondents (66.7%) stated that further advanced platforms are needed to ensure safe and efficient telemedicine as a substitute for in-person treatment. There were additional opinions that a remote digital measuring instrument for vital signs and a nervous system function evaluation system could prove beneficial.

DISCUSSION

This study aims to gather insights and experiences from expert panels through the Delphi process to develop a suitable response plan in the event of a potential crisis that might cause a scarcity of healthcare resources in the future. The final consensus recommendations for the management of brain tumor patients during a crisis period have been summarized in Table 3 based on the result of the Delphi process. The KSNO Guideline Working Group acknowledges the need for a personalized management plan for each brain tumor patient, best discussed and implemented within a hospital-based multidisciplinary team. The consensus recommendations outlined in this guideline can serve as a reference for these discussions.

The surgical prioritization level described in this guideline was developed by adopting "time window-based criteria" from other guidelines during the COVID-19 pandemic with modifications to suit the domestic medical situation [7,8]. While other guidelines have presented a more specific surgical prioritization based on clinical scenarios [9], this approach may limit flexibility and adaptability during future crisis periods. It is also necessary to apply the surgical priority reevaluation system mentioned in this guideline to each medical facility's circumstances. The neurosurgical treatment algorithm and checklist system developed by the University of California, San Francisco (UCSF) group during the COVID-19 pandemic may be useful in reevaluating surgical priority during crisis periods [7].

Previous radiotherapy guidelines for crisis periods such as COVID-19 have suggested prioritizing patients for radiotherapy based on their diagnosis [10,11]. However, in this consensus guideline, Korean neuro-oncologists have prioritized patients for radiotherapy based on the timing of radiotherapy and the potential benefit in terms of oncological and neurological outcomes. Evidence from prospective randomized studies have demonstrated comparable outcomes with radiotherapy of 60 Gy in 6 weeks, 40 Gy in 3 weeks, 34 Gy in 2 weeks, and 25 Gy in 1 week in elderly patients with glioblastoma when treated with radiotherapy alone [12-16]. In this context, hypofractionated radiotherapy is the preferred regimen for elderly patients with high-grade gliomas when medical resources are limited during a crisis. Among the hypofractionated dose-fractionation schedules, many Korean neuro-oncologists (57.1%) feel comfortable using the 3-week 40−45 Gy regimen for high-grade gliomas. Tabrizi et al. [17] reported that individual elderly glioblastoma patients' risk of COVID-19 infection and mortality was mathematically calculated using hypothetical scenarios (low-, medium-, and high-risk scenarios) based on published prospective trials [14,16]. The calculated risks were then compared with the risk of death due to glioblastoma. The study found that reducing visits to the radiotherapy facility with hypofractionation resulted in non-inferior outcomes compared to 6-week radiotherapy.

Consensus recommendations on chemotherapy during crisis periods emphasize the need to balance effective treatment with resource limitations. This viewpoint is in line with several guidelines [10,18,19]. The panel agreed that priority should be given to treatments with a higher chance of cure and long-term survival, such as curative-intent and neoadjuvant/adjuvant chemotherapies. In contrast, palliative chemotherapy that does not significantly relieve tumor-related symptoms should be postponed. It is worth noting that multimodal treatment plans, including surgery, radiotherapy, and chemotherapy, are often necessary to achieve long-term survival and cure. For example, in patients with glioblastoma, omission of radiotherapy and/or temozolomide leads to a worse prognosis compared to the standard protocol [20-22]. If it is not feasible to provide post-surgery treatment during a crisis period, curative-intent surgery may not be justified. Thus, the panel emphasizes the importance of providing the best possible care through a multidisciplinary approach.

The panel has reached a consensus regarding the prioritization of chemotherapy regimens that effectively balance efficacy and low toxicity, thereby reducing the number of hospital visits for patients. In addition, to ensure patient safety, the consensus recommends the suspension of new clinical trial registrations and only the continuation of ongoing trials. In the case of oligodendroglioma with 1p19q codeletion, the current standard treatment after surgical resection is radiotherapy along with neoadjuvant or adjuvant PCV (procarbazine, lomustine, and vincristine) [23,24]. The adjuvant PCV regimen has been shown to improve overall survival and progression-free survival in patients with 1p19q codeleted oligodendroglioma compared to radiotherapy alone [25]. However, the PCV regimen is associated with a higher toxicity profile and requires more frequent hospital visits for intravenous vincristine and multiple-dose oral medication schedule [23,24]. On the other hand, radiotherapy with concurrent and adjuvant temozolomide has a relatively lower toxicity profile and a simpler dosing schedule without intravenous drug administra-

Table 3. Recommendations of the Korean Society for Neuro-Oncology (KSNO) for managing brain tumor patients during the crisis period

Recommendation	Consensus
General treatment priority	
• The presence of acute neurological deterioration with increased intracranial pressure (IICP) is the most important factor in determining the treatment priority during the crisis period.	Highly recommended
• A newly diagnosed case has treatment priority over a recurred case during the crisis period if it shows similar clinical characteristics, including the severity of neurologic symptoms, tumor type, patient's age, and so on.	Recommended
• A patient with poor life expectancy despite immediate therapy (such as elderly glioblastoma [GBM], recurrent/progressive GBM, or brain metastasis with uncontrolled primary cancer) can be delayed in the treatment priority during the crisis period. However, a sufficient discussion with the patient and their families should be required.	Highly recommended
Surgery	
• Proposed surgical priority during the crisis period (Table 1).	Highly recommended
• It can consider limiting the extent of surgical resection for a malignant tumor with a relatively bad prognosis during the crisis for the effective distribution of restricted medical resources. However, it should be determined after thoughtfully considering the severity of the crisis.	Recommended
• If a brain tumor patient with a legally communicable disease requires surgical intervention, it is considered in case only for the patient with surgical priority A.	Highly recommended
• A reassessment of surgical priority during the crisis is required. Reassessment means adjusting the surgical priority according to availability of medical resources, whether the patient's neurological aggravation, and whether adjuvant treatment will be given.	Highly recommended
• A benign tumor with a good prognosis can have surgical priority over a malignant tumor with a relatively bad prognosis during the crisis.	No consensus
Pathology	
• In the restricted situation of medical resources for diagnosis of WHO 2021 diffuse glioma during the crisis, further treatment for diffuse glioma patients can be proceeded based on traditional histological diagnosis without molecular information.	Highly recommended
Radiotherapy	
• Proposed radiotherapy priority during the crisis period (Table 2).	Highly recommended
• During the crisis period with strained health care resources, hypofractionated radiotherapy can be preferred to conventional fractionation in elderly patients with high-grade gliomas.	Highly recommended
• During the crisis, the most preferred hypofractionated short-course radiotherapy schedule for patients with high-grade gliomas is 40–45 Gy in 15 daily fractions. But it can be adjusted according to the severity of the crisis period.	Recommended
• For efficient utilization of medical resources during the crisis, hypofractionated short-course radiotherapy for brain tumors should be considered in cases where adequate treatment efficacy is expected, or sufficient evidence is published.	Highly recommended
• If a brain tumor patient with a legally communicable disease requires radiotherapy, it is considered in case only for the patient with radiotherapy priority A.	Highly recommended
Chemotherapy	
• Curative-intent chemotherapy has the highest priority followed by neoadjuvant/adjuvant and palliative chemotherapy.	Highly recommended
• Neoadjuvant/adjuvant chemotherapy should be prioritized over palliative chemotherapy.	Highly recommended
• Proceed with chemotherapy during the crisis period only when it may markedly improve the prognosis of patients or significantly alleviate tumor-related symptoms.	Highly recommended
• Although not the most effective, chemotherapy regimen which has relatively good efficacy and low toxicity, and can minimize visits to medical institutions should be prioritized.	Highly recommended
• For non-emergency patients, when chemotherapy cannot be performed immediately due to lack of medical resources, postpone chemotherapy for a certain period of time, and if the problem is not resolved during that period, the patient is transferred to a medical institution in a region where treatment is available.	Highly recommended
• Decisions through a multidisciplinary approach/care are appropriate to determine chemotherapy regimen for a patient during the crisis period if possible.	Recommended

Table 3. Recommendations of the Korean Society for Neuro-Oncology (KSNO) for managing brain tumor patients during the crisis period (continued)

Recommendation	Consensus
Clinical trial	
• Only ongoing subjects maintained, and new subjects registration and new clinical trials should be suspended.	Highly recommended
Radiological surveillance	
• In case of complete response (CR) status after completion of standard treatment in patients with a primary malignant brain tumor (e.g., malignant glioma) who have finished standard treatment in a crisis period, the adequate timing of f/u MRI can proceed with a longer f/u period than the existing protocol.	Highly recommended
• In case of partial response (PR) status after completion of standard treatment in patients with a primary malignant brain tumor (e.g., malignant glioma) who have finished standard treatment in a crisis period, the adequate timing of f/u MRI can proceed with a longer f/u period than the existing protocol.	Highly recommended
• In case of stable disease (SD) status after completion of standard treatment in patients with a primary malignant brain tumor (e.g., malignant glioma) who have finished standard treatment in a crisis period, the adequate timing of f/u MRI can proceed with a longer f/u period than the existing protocol.	Highly recommended
• In case of complete response (CR) status after treatment (surgery, stereotactic radiosurgery [SRS], whole brain radiation therapy [WBRT] or chemotherapy [CTx], or combined treatment) for brain metastasis in a crisis period, the adequate timing of f/u MRI can proceed with a longer f/u period than the existing protocol.	Highly recommended
• In case of partial response (PR) status after treatment (surgery, SRS, WBRT or CTx, or combined treatment) for brain metastasis in a crisis period, the adequate timing of f/u MRI can proceed with a longer f/u period than the existing protocol.	Highly recommended
• In case of stable disease (SD) status after treatment (surgery, SRS, WBRT or CTx, or combined treatment) for brain metastasis in a crisis period, the adequate timing of f/u MRI can proceed with a longer f/u period than the existing protocol.	Highly recommended
• It is possible to postpone f/u MRI for patients with benign brain tumors without clinical signs of progression in a crisis period until the crisis has been resolved.	Highly recommended
• When considering imaging tests for patients with an extra-axial brain tumor in a crisis period, assuming that the resource for the MRI test is limited, it can be replaced with CT (contrast or non-contrast).	Highly recommended
• When considering imaging tests for patients with an intra-axial brain tumor in a crisis period, assuming that the resource for the MRI test is limited, it can be replaced with CT (contrast or non-contrast).	Recommended
Telemedicine	
• Telemedicine can be actively considered when treating brain tumor patients in an infectious disease crisis such as the coronavirus disease 2019 (COVID-19) pandemic.	Highly recommended
• When conducting telemedicine for brain tumor patients, in addition to video and audio platforms, additional enhanced platforms are needed.	Recommended
• In patients with primary malignant brain tumors (e.g., malignant glioma) who have completed standard treatment, telemedicine can be substituted, except for cases in which the disease status is progressive disease (PD) (i.e., whether additional treatment should be discussed, or additional treatment methods should be discussed).	Highly recommended
• For follow-up in patients who have undergone treatment (surgery or SRS or WBRT or Chemotherapy or combined treatment) for brain metastasis, telemedicine can be substituted, except for cases in which the disease status is PD (i.e., whether additional treatment should be discussed, or additional treatment methods should be discussed).	Highly recommended
• For postoperative follow-up of patients with benign brain tumors (e.g., grade 1 meningioma, schwannoma, pituitary adenoma, etc.), it can be replaced by telemedicine, regardless of whether there is a residual tumor.	Highly recommended
• It is possible to substitute telemedicine for a patient interview or progress check during chemotherapy, in an infectious disease crisis such as the COVID-19 pandemic.	Highly recommended
• It is possible to substitute telemedicine for a patient interview or progress check during radiotherapy, in an infectious disease crisis such as the COVID-19 pandemic.	Highly recommended
• It is not possible to substitute telemedicine for a new patient who needs surgery.	Recommended
• It is not possible to substitute telemedicine for a new patient who needs radiation therapy.	Recommended
• It is not possible to substitute telemedicine for a new patient who needs chemotherapy.	Recommended

tion [26]. The initial results of the ongoing CODEL phase III randomized trial indicate a 5-year overall survival rate of 91% in patients receiving concurrent and adjuvant temozolomide in combination with radiotherapy in 1p19q codeleted oligodendroglioma [27]. Despite the preliminary and inconclusive nature of these results, the consensus recommendation determined by the panel and previous study results do not necessarily suggest a clear advantage for PCV-based adjuvant therapy over alternative postoperative treatment strategies for grade 2 or 3 gliomas during the crisis period [28].

With the COVID-19 outbreak, non-face-to-face medical care has gained significant momentum, and there has been a surge of interest in telemedicine. While many patients have hailed its convenience, some medical professionals have been cautious of its potential risks. As a result, several IT companies are now expediting the development of platforms related to telemedicine. Moreover, many countries are also making changes to their legal systems to accommodate this new paradigm. Recently, several preliminary studies on feasibility of telemedicine have been reported according to this atmosphere [29-31]. The present guideline also tried to explore the potential role and direction that telemedicine may have in the field of neuro-oncology in the future.

In the event of future crises that result in a shortage of medical resources, such as the COVID-19 pandemic, it is expected that these consensus recommendations will serve as a reference for prioritizing the management of brain tumor patients. They will also provide guidance for making decisions in various scenarios that may arise during the management of brain tumor patients. Additionally, it is worth noting that the development of these guidelines differs from the conventional method of developing clinical guidelines, which typically rely on evidence from a review of existing literature. This guideline was developed through the Delphi process, which involves synthesizing and consolidating the opinions of experts by inducing their views and reaching a consensus judgment, to solve specific problems. The experience of the KSNO Guideline Working Group in this process is expected to serve as a valuable foundation for future guideline development when similar needs arise.

Supplementary Materials

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Availability of Data and Material

All data generated or analyzed during the study are included in this published article and its supplementary information files.

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Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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Final Survey Results

<Treatment priority>

Q1) Which factors do you consider most important in determining the treatment priority during the crisis?

1. Presence of acute neurological deterioration with increased intracranial pressure (IICP) (85.7%)

2. Tumor growth (or progression) rate.

3. Possibility of neurologic recovery after treatment. (9.5%)

4. Long-term prognosis of the tumor after treatment. (4.8%)

5. Patient's age.

6. Underlying disease of the patient.

Q2) If you think of another factor besides the factors presented in question 1 in determining the treatment priority during the crisis, describe it.

Panel's opinions>

1. Whether a newly diagnosed case is.

2. Availability of medical resources.

3. Whether the necessity of combined treatment is.

Q3) Do you agree that a newly diagnosed case has treatment priority over a recurred case with similar clinical characteristics including neurologic symptoms, tumor type, patient's age,

and so on during the crisis? (e.g., newly diagnosed GBM vs. recurred GBM or newly diagnosed meningioma vs. recurred meningioma)

1. Agree (71.4%)

2. Disagree (23.8%)

3. Others (4.8%): according to tumor type.

Q4) Do you agree that a patient with poor life expectancy despite immediate therapy can be delayed in the treatment priority during the crisis? (e.g., elderly GBM, recurrent or progressive GBM, brain metastasis with uncontrolled primary cancer) (presupposed sufficient discussion with patients and their families)

1. Agree (100%)

<Pathology>

Q1) In the restricted situation of medical resources for diagnosis of WHO 2021 diffuse glioma during the crisis, do you agree to proceed with further treatment for diffuse glioma patients based on traditional histological diagnosis without molecular information?

1. Agree (95.2%)

2. Abstention (4.8%)

<Surgery>

Q1) Do you agree that a benign tumor with a good prognosis has surgical priority over a malignant tumor with a relatively bad prognosis during the crisis?

1. Agree (42.9%)
2. **Disagree (52.4%)**
3. Abstention (4.7%)

Q2) For surgical resection of a malignant tumor with a relatively bad prognosis, do you agree it can limit the extent of surgical resection for the effective distribution of restricted medical resources?

1. **Agree (52.4%)**
2. Disagree (42.9%)
3. Abstention (4.7%)

Q3) Do you agree with the below the level of surgical priority during the crisis?

Priority A (immediate, <24-48 hours): Patients in whom surgery is required within 24-48 hours because of life-threatening risk or significantly altering the patient's prognosis.
Priority B (< 4 weeks): Patients for whom a delay of < 4 weeks from target would not be anticipated to impact significantly on the patient's prognosis.
Priority C (< 2-3 months): Patients for whom a delay of 2-3 months would be unlikely to affect the patient's prognosis.

1. Agree (95.2%)

2. Disagree (4.8%)

Q4) Do you proceed with the surgical intervention if a patient with a brain tumor suffers from a legally communicable disease?

1. I will perform the surgical intervention for all patients regardless of whether a patient suffers from a legally communicable disease.

2**. I will perform the surgical intervention only for the patient with surgical priority A. (90.5%)**

3. I will postpone the surgical intervention for all patients until the isolation period from a legally communicable disease is finished. (4.8%)

4. Abstention (4.7%)

Q5) Do you think any situations besides the patient with surgical priority A that we have to proceed with the surgical intervention if a patient with a brain tumor suffers from a legally communicable disease?

Q6) Do you agree with the system for reevaluating surgical priority during the crisis?

1. Agree (95.2%)

2. Abstention (4.8%)

Q7) What factors do we have to consider for reevaluating the surgical priority during the crisis?

Panel’s opinions>

1. Whether the patient’s neurological aggravation.

2. Availability of medical resources (operating room, ICU beds)

3. Whether adjuvant treatment will be given.

<Radiotherapy>

Q1) During the crisis period with strained health care resources, do you agree that hypofractionated radiotherapy can be preferred to conventional fractionation in elderly patients with high-grade gliomas?

1. **Agree (100.0%)**
2. Disagree (0.0%)

Q2) Please describe other clinical scenarios during the crisis in high-grade gliomas other than elderly patients where hypofractionated short-course radiotherapy should be considered over conventionally fractionated standard radiotherapy in 6 weeks?

1. **Patients with poor performance status or frail patients (70.6%)**
2. Patients with limited expected survival or poor prognosis (47.1%)
3. In no other scenarios other than elderly patients (23.5%)

Q3) During the crisis, what is the most preferred hypofractionated short-course radiotherapy schedule for patients with high-grade gliomas?

1. **40–45 Gy in 15 daily fractions (57.1%)**
2. Depends on the severity of shortage of medical resources (28.6%)
3. 34 Gy in 10 daily fractions (9.5%)
4. 25–30 Gy in 5 daily fractions (4.8%)

Q4) For efficient utilization of medical resources during the crisis, which of the following is appropriate in terms of choosing the radiotherapy schedule?

1. **Consider hypofractionated short-course radiotherapy in cases where adequate treatment efficacy is expected or sufficient evidence is published (76.2%)**
2. Strongly consider hypofractionated short-course radiotherapy over conventionally fractionated standard radiotherapy in 6 weeks (23.8%)
3. Consider conventionally fractionated standard radiotherapy in 6 weeks in all cases (0.0%)

Q5) Which criteria is more appropriate for prioritizing radiotherapy treatments?

Priority classification 1

Priority level	**Description**
High (level A)	Cases where compromised overall survival or neurology is expected unless radiotherapy is initiated immediately or within 4–6 weeks
Medium (level B)	Cases where compromised progression-free survival or local control is expected unless radiotherapy is initiated within 3 months
Low (level C)	Cases where radiotherapy is not expected to substantially affect prognosis (e.g. radiotherapy for palliation of mild symptoms)

Priority classification 2

Priority level	**Description**
High (level A)	1. Cases where progressive neurologic symptom is present or impending (e.g. benign brain tumors with optic neuropathy, posterior fossa tumors causing life-threatening hydrocephalus) 2. Young and fit patients with high-grade gliomas 3. Adult medulloblastoma patients
Medium (level B)	Patients with symptomatic low-grade gliomas or meningiomas
Low (level C)	1. Elderly/frail patients with high-grade gliomas 2. Re-irradiation for gliomas 3. Asymptomatic patients with meningioma, pituitary adenoma, craniopharyngioma, pilocytic astrocytoma, or completely resected low-grade glioma 4. trigeminal neuralgia or schwannomas 5. Patients with expected survival less than 6 months

1. **Priority classification 1 (85.7%)**
2. Priority classification 2 (14.3%)

Q6) In brain tumor patients requiring radiotherapy during the crisis period, for which priority level (refer to Q5) would you plan radiotherapy?

1. **High priority (level A) only (81.0%)**
2. Medium priority (level B) or higher (9.5%)
3. In all cases irrespective of priority level or severity of strained health care resource (4.8%)
4. Delay radiotherapy in all cases until the crisis is over (4.8%)

Q7) In case you have answered 'High priority (level A)' for Q6, which specific clinical scenarios other than priority level A can be strongly considered for radiotherapy during the crisis period?

Panel's opinions>

In cases where you can expect very high response rates with radiotherapy such as germinoma or lymphoma, and chemotherapy is not feasible due to the shortage of health care resources

Q8) In which newly diagnosed brain tumor is survival likely to be compromised by delaying radiotherapy due to strained health care resources? (assume that standard systemic therapy is performed in all cases)

Panel's opinions>

1. **High-grade glioma (including glioblastoma)**

2. **Medulloblastoma**
3. **Germ cell tumors**
4. **Other primary malignant brain tumors (anaplastic meningioma, anaplastic ependymoma)**
5. **Primary central nervous system lymphoma**
6. **Metastatic brain tumors with rapid progression (e.g. small cell lung cancer)**

<Chemotherapy & clinical trial>

Q1) How should clinicians proceed with chemotherapy during the crisis period?

1. All chemotherapy should be suspended and not be started
2. **Proceed with chemotherapy when it may markedly improve the prognosis of patients or significantly alleviate tumor-related symptoms (85.7%)**
3. Proceed with chemotherapy according to standard treatment guideline without any special restrictions (9.5%)
4. others (4.8%)

Q2) What are best priorities according to the goals of chemotherapy during the crisis period? (in order of priority)

1. **Curative – neoadjuvant/adjuvant – palliative (85.7%)**
2. Curative – palliative – neoadjuvant/adjuvant (9.5%)
3. Neoadjuvant/adjuvant – curative – palliative
4. Neoadjuvant/adjuvant – palliative – curative
5. Palliative – curative – neoadjuvant/adjuvant
6. Palliative – neoadjuvant/adjuvant – curative
7. Proceed with chemotherapy without prioritization
8. Abstention (4.8%)

Q3) Which should be prioritized between neoadjuvant/adjuvant chemotherapy and palliative chemotherapy during the crisis period?

1. **Neoadjuvant/adjuvant (85.7%)**
2. Palliative (9.5%)
3. Abstention (4.8%)

Q4) Which chemotherapy regimen should be prioritized given efficacy, toxicity, and accessibility during the crisis period?

1. Most effective, but toxic and requiring frequent visits to medical institutions (4.8%)
2. **Although not the most effective, it is relatively good, has low toxicity, and can minimize visits to medical institutions (85.7%)**
3. Select chemotherapy regimen according to standard treatment guideline without considering the crisis (4.8%)
4. Abstention (4.8%)

Q5) How to manage non-emergency patients when chemotherapy cannot be performed immediately due to lack of medical resources during the crisis period?

1. Postpone chemotherapy indefinitely until medical resources shortages are resolved (4.8%)
2. **Postpone chemotherapy for a certain period of time, and if the problem is not resolved during that period, the patient is transferred to a medical institution in a region where treatment is available (85.7%)**
3. Transfer the patient immediately to a medical institution in a region where treatment is available (4.8%)

4. Abstention (4.8%)

Q6) Which department is appropriate to determine chemotherapy regimen for a patient for during the crisis period?

1. Department currently applying chemotherapy (38.1%)
2. Medical oncology (4.8%)
3. Radiation oncology
4. Neurosurgery
5. **Decisions through a multidisciplinary approach/care (52.4%)**
6. others (4.8%)

Q7) How should clinical trials be conducted during the crisis period?

1. All clinical trials should be suspended (4.8%)
2. **Only ongoing subjects are maintained, and new subjects registration and new clinical trials are suspended (76.2%)**
3. Initiate and maintain clinical trials without restrictions (14.3%)
4. Abstention (4.8%)

<Radiological surveillance>

Q1) What is the adequate timing of f/u MRI according to each disease status (CR, PR, SD, PD), in patients with primary malignant brain tumor (e.g. malignant glioma) who have finished standard treatment in a crisis situation? (Assuming there is no clear evidence for clinical progression or recurrence)

Q1-1) In case of complete response (CR) status after completion of standard treatment.

1. Regardless of the crisis situation, proceed according to the existing protocol. (4.8%)
2. **Proceed with a longer f/u period than the existing protocol (66.7%)**
3. If there is no evidence of clinical progression, postpone until the crisis situation is resolved. (23.8%)
4. Abstention (4.8%)

Q1-2) In case of partial response (PR) status after completion of standard treatment.

1. Regardless of the crisis situation, proceed according to the existing protocol. (4.8%)
2. **Proceed with a longer f/u period than the existing protocol. (71.4%)**
3. If there is no evidence of clinical progression, postpone until the crisis situation is resolved. (19%)
4. Abstention (4.8%)

Q1-3) In case of stable disease (SD) status after completion of standard treatment.

1. Regardless of the crisis situation, proceed according to the existing protocol. (4.8%)
2. **Proceed with a longer f/u period than the existing protocol. (71.4%)**
3. If there is no evidence of clinical progression, postpone until the crisis situation is resolved. (19%)

4. Abstention (4.8%)

Q2) What is the adequate timing of f/u MRI after treatment (surgery, SRS, WBRT or CTx or combined treatment) for brain metastasis in a crisis situation based on each disease status (CR, PR, SD, PD)? (Assuming there is no clear evidence for clinical progression or recurrence of brain metastasis)

Q2-1) In case of complete response (CR) status after treatment.

1. Regardless of the crisis situation, proceed according to the existing protocol.
2. **Proceed with a longer f/u period than the existing protocol. (66.7%)**
3. If there is no evidence of clinical progression, postpone until the crisis situation is resolved. (28.6%)
4. Abstention (4.8%)

Q2-2) In case of partial response (PR) status after treatment.

1. Regardless of the crisis situation, proceed according to the existing protocol.
2. **Proceed with a longer f/u period than the existing protocol. (81%)**
3. If there is no evidence of clinical progression, postpone until the crisis situation is resolved. (14.3%)
4. Abstention (4.8%)

Q2-3) In case of stable disease (SD) status after treatment.

1. Regardless of the crisis situation, proceed according to the existing protocol.
2. **Proceed with a longer f/u period than the existing protocol. (76.2%)**

3. If there is no evidence of clinical progression, postpone until the crisis situation is resolved. (19%)
4. Abstention (4.8%)

Q3) Is it possible to postpone f/u MRI for patients with benign brain tumors without clinical signs of progression in a crisis situation until the crisis has been resolved?

1. **Agree (95.2%)**
2. Disagree
3. Abstention (4.8%)

Q4) When considering f/u MRI for patients with benign brain tumor in a crisis situation, even if there is no evidence of clinical progression, if you think that there is a clinical situation in which the f/u imaging test should proceed, please briefly describe the reason along with the reason.

Panel's opinions>

1. **Residual malignant tumor with imaging changes**
2. **Types of tumors known to be at high risk for malignant transformation**
3. **When it is judged that there is a serious risk of irreversible increase in size, the lesion near the brainstem and the lesion near the cranial nerve.**
4. **Clinical findings are the most important.**
5. **The examination planning based on tumor growth rate**

Q5) When considering imaging tests for patients with extra-axial tumor in a crisis situation, do you think other test can be substituted for MRI? (Assuming that the resource for the MRI test is limited)

1. **Yes. It can be replaced with CT (contrast or non-contrast). (76.2%)**
2. No. MRI examination must be performed, even if the MR sequence should be reduced. (19%)
3. Abstention (4.8%)

Q6) When considering imaging tests for patients with intra-axial tumor in a crisis situation, do you think other test can be substituted for MRI? (Assuming that the resource for the MRI test is limited)

1. **Yes. It can be replaced with CT (contrast or non-contrast). (57.1%)**
2. No. MRI examination must be performed, even if the MR sequence should be reduced. (38.1%)
3. Abstention (4.8%)

<Telemedicine>

Q1) In general, telemedicine is basically done via a platform with the video and audio between the doctor and the patient. Do you think that even when conducting telemedicine for brain tumor patients, it is possible to do it with only with a video and audio platform?

1. This is possible only with a video and audio platforms. (33.3%)
2. **In addition to video and audio platforms, additional enhanced platforms are needed. (66.7%)**

Q2) Do you think enhanced platforms for efficient and safe telemedicine can replace face-to-face treatment when considering telemedicine for brain tumor patients in an infectious disease crisis such as the COVID-19 pandemic? If yes, please be specific.

Panel's opinions>

1. **A platform with tele-neurological function assessment system**
2. **Remote measurement and transmission of blood pressure/body temperature/BMI/sugar level, remote stethoscope, remote digital hearing/vision meter, remote nervous system function evaluation system**
3. **Digital measuring instrument for vital signs and remote nervous system function evaluation system**
4. **It is possible in a general case, but it seems that there must be a platform that will help in situations where physical exam or cranial nerve function evaluation is possible when there is a first visit or a change in the patient's condition.**

<Q3~Q6 In the following questions about whether telemedicine can be substituted, it is assumed that the platform and technology for telemedicine are sufficiently equipped for telemedicine>

Q3) Do you agree that telemedicine can be actively considered when treating brain tumor patients in an infectious disease crisis such as the COVID-19 pandemic?

1. **agree (100%)**

Q4) These are questions about whether telemedicine can be substituted for each clinical situation in an infectious disease crisis such as the COVID-19 pandemic.

Q4-1) In patients with primary malignant brain tumors (e.g. malignant glioma) who have completed standard treatment, what do you think about replacing face-to-face treatment with telemedicine for a follow-up?

1. Regardless of disease status (CR, PR, SD, PD), it is possible to substitute to telemedicine for all. (14.3%)
2. **Except for cases in which the disease status is PD (i.e., whether additional treatment should be discussed or additional treatment methods should be discussed), telemedicine can be substituted. (85.7%)**
3. Telemedicine is impossible in all cases

Q4-2) What do you think about replacing face-to-face treatment with telemedicine for follow-up in patients who have undergone treatment (surgery or SRS or WBRT or Chemotherapy or combined treatment) for brain metastasis?

1. Regardless of disease status (CR, PR, SD, PD), it is possible to substitute to telemedicine for all. (14.3%)
2. **Except for cases in which the disease status is PD (i.e., whether additional treatment should be discussed or additional treatment methods should be discussed), telemedicine can be substituted. (85.7%)**
3. Telemedicine is impossible in all cases

Q4-3) What do you think about replacing face-to-face treatment with telemedicine for postoperative follow-up of patients with benign brain tumors (e.g. grade 1 meningioma, schwannoma, pituitary adenoma, etc.)?

1. **Regardless of whether there is a residual tumor, it can be replaced by telemedicine. (90.5%)**
2. Telemedicine can be substituted only in completely resected cases. (9.5%)
3. Telemedicine is impossible in all cases

Q5) These are questions about whether telemedicine can be substituted for patient interviews or progress checks during chemotherapy or radiation treatment in an infectious disease crisis such as the COVID-19 pandemic.

Q5-1) Is it possible to substitute telemedicine for a patient interview or progress check during chemotherapy?

1. **Substitutable (90.5%)**
2. Unsubstitutable. (4.8%)
3. Abstention (4.8%)

Q5-2) Is it possible to substitute telemedicine for patient interviews or progress checks during radiotherapy?

1. **Substitutable (95.2%)**
2. Unsubstitutable (4.8%)

Q6) These are questions about whether telemedicine can be substituted for treating new patients in an infectious disease crisis such as the COVID-19 pandemic.

Q6-1) Is it possible to substitute telemedicine for the treatment of new patients in neurosurgery who need surgery?

1. Substitutable (23.8%)
2. **Unsubstitutable (71.4%)**
3. Abstention (4.8%)

Q6-2) Is it possible to substitute telemedicine for the treatment of new patients in neurosurgery who need radiation therapy?

1. Substitutable (33.3%)
2. **Unsubstitutable (66.7%)**

Q6-3) Is it possible to substitute telemedicine for the treatment of new patients in neurosurgery who need chemotherapy?

1. Substitutable (33.3%)
2. **Unsubstitutable. (61.9%)**
3. Abstention (4.8%)