Barriers and facilitators in the implementation of a telemedicine-based outpatient brain tumor surgery program

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OBJECTIVE Despite growing evidence on the benefits of outpatient oncological neurosurgery (OON), it is only performed in a few specialized centers and there are no previous descriptions of established OON programs in Europe. Moreover, increasing application of telemedicine strategies, especially after the start of the coronavirus disease 2019 (COVID-19) pandemic, is drastically changing neurosurgical management, particularly in the case of vulnerable populations such as neuro-oncological patients. In this context, the authors implemented an OON program in their hospital with telematic follow-up. Herein, they describe the protocol and qualitatively analyze the barriers and facilitators of the development process.

METHODS An OON program was developed through the following steps: assessment of hospital needs, specific OON training, multidisciplinary team organization, and OON protocol design. In addition, the implementation phase included training sessions, a pilot study, and continuous improvement sessions. Finally, barriers and facilitators of the protocol's implementation were identified from the feedback of all participants.

RESULTS An OON protocol was successfully designed and implemented for resection or biopsy of supratentorial lesions up to 3 cm in diameter. The protocol included the patient's admission to the day surgery unit, noninvasive anesthetic monitoring, same-day discharge, and admission to the hospital-at-home (HaH) unit for telematic and on-site postoperative care. After a pilot study including 10 procedures in 9 patients, the main barriers identified were healthcare provider resistance to change, lack of experience in outpatient neurosurgery, patient reluctance, and limitations in the recruitment of patients. Key facilitators of the process were the patient education program, the multidisciplinary team approach, and the HaH-based telematic postoperative care.

CONCLUSIONS Initiating an OON program with telematic follow-up in a European clinical setting is feasible. Nevertheless, it poses several barriers that can be overcome by identifying and maximizing key facilitators of the process. Among them, patient education, a multidisciplinary team approach, and HaH-based postoperative care were crucial to the success of the program. Future studies should investigate the cost-effectiveness of telemedicine to assess potential cost savings, from reduced travel and wait times, and the impact on patient satisfaction.

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KEYWORDS telemedicine; outpatient neurosurgery; neuro-oncology; hospital management; day surgery; enhanced recovery after surgery; hospital-at-home unit; ambulatory neurosurgery

ABBREVIATIONS COVID-19 = coronavirus disease 2019; ERAS = enhanced recovery after surgery; HaH = hospital at home; OON = outpatient oncological neurosurgery; UK = United Kingdom.


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OUTPATIENT surgery and enhanced recovery after surgery (ERAS) protocols have become standards of care for many procedures in several surgical specialties. Currently, patients with greater comorbidity and undergoing complex procedures are more frequently suitable for ambulatory surgery.1

In oncological neurosurgery, outpatient surgery has been proven to be safe.2–9 Furthermore, it has been associated with a reduction in complications arising from hospitalization, including nosocomial infections, thromboembolism, and iatrogenic complications due to medical errors, and it has a positive impact on the psychosocial sphere of the patient.10 In addition, it may help to optimize hospital bed flow and healthcare costs.11 However, even though recent advances in neurosurgery and neuroanesthesia have resulted in fewer postoperative complications, faster recovery, and earlier discharge,12–15 outpatient procedures in oncological neurosurgery are not widely performed. Moreover, despite its potential benefits for the patient and the healthcare system, outpatient oncological neurosurgery (OON) has not gained widespread popularity among neurosurgeons.10 Even well-established OON programs are limited to only a few specialized centers, and to the best of our knowledge, there are no previously published descriptions of OON programs in European settings.

Within this framework, there may be several barriers to the process of initiating a telemedicine-based OON program, from concerns about neurological deterioration after a patient’s discharge to the complexity of medicolegal issues.10 Consequently, to illustrate a practical approach for initiating such a program, herein we aimed to describe in detail an OON protocol initiated at a European tertiary care center and to perform a qualitative analysis of the barriers and facilitators of the process. We also provided a complete description of all the steps followed for program implementation as well as the telemedicine strategies applied during the coronavirus disease 2019 (COVID-19) pandemic. We hope that this will encourage OON in other neuro-oncology units, with potential benefits for the patient and the healthcare system.

Methods

Ethical Aspects

The OON program received approval from the Clinical Research Ethical Committee, and all the precepts established in the Declaration of Helsinki were followed accordingly.

Clinical Setting

The clinical setting is a tertiary care hospital within the social security system in Spain and serves a population of approximately 580,000 inhabitants in a 5321-km² area. The neurosurgery and anesthesiology departments provide dedicated care in all neurosurgical subspecialties with a well-established neuro-oncology program but with limited experience in outpatient neurosurgery. Both departments are highly equipped with up-to-date technological resources. The hospital-at-home (HaH) department has a dedicated medical and nursing staff for providing medical care at home for several pathologies. It serves a population of 253,000 inhabitants within a radius of 20 km. The HaH unit is formed by a multidisciplinary team including internists and nurses with extensive experience in ambulatory procedures and ERAS protocols in other surgical specialties.

Program Development

The main steps in the development of the OON program included the following: 1) hospital needs and resources assessment, 2) specific OON training at experienced centers, 3) multidisciplinary team organization, and 4) OON protocol design. In brief, the types of neuro-oncological procedures performed in the neurosurgery department that could be performed on an outpatient basis were identified. Moreover, the staff coordinating the neurosurgery and anesthesiology teams underwent specific training at the Toronto Western Hospital, Toronto, Ontario, Canada, which has extensive experience in OON.8,9,16 Then, the local team was organized by selecting clinically experienced individuals from the three units involved, that is, neurosurgery, anesthesiology, and HaH. The team also incorporated a process management specialist, and key allied health representatives—neuroradiologists, operating room nurses, and allied healthcare providers—were also identified. Finally, once organized, the OON team designed a mutually agreed upon and tailored protocol. In addition, a comprehensive educational guide for patients and their relatives was designed, including detailed information regarding all steps of the process.

Implementation of the Program

The protocol was executed through several steps: 1) dedicated training for healthcare providers, 2) pilot study, and 3) continuous process improvement. Dedicated training sessions provided all stakeholders with clear insight into OON and the specific needs of the neuro-oncological patient in the perioperative course. In addition, brief fact sheets containing key information on the process were made available to neurosurgery staff. The protocol was then applied in a pilot study including 10 procedures in 9 patients. Patient recruiting was performed according to strict inclusion and exclusion criteria (Table 1). In addition, for continuous process improvement, all cases were analyzed on an individual basis in regular team meetings to assess outcomes and areas for improvement. Moreover, all barriers and facilitators of the process were identified from the feedback of all stakeholders.

Results

The program development phase resulted in a well-defined and simple OON protocol. A description of and the essential steps in the protocol are summarized in Figs. 1–3, and illustrative cases are described in Figs. 4–7. Furthermore, the barriers and facilitators identified during the process are summarized and briefly described in Table 2.

Description of the OON Program and Team Logistics

In brief, during the preoperative assessment, patients
and relatives received detailed information about the procedure. The OON Patient Information Guide was used to reinforce their understanding of the process. Tumor resection could be performed under general anesthesia or as an awake craniotomy following the asleep-awake-asleep protocol. During the pilot study, tumor resection was performed while the patient was under general anesthesia, with noninvasive monitoring in all cases (Figs. 4B and 6B), avoiding central venous and arterial lines and urinary catheters. After standard positioning and surgical field prepping, the procedure was performed, avoiding large pediculated scalp flaps and administering a long-lasting local anesthetic at the end. All standard operative adjuncts— intraoperative fluorescence, neuronavigation, mapping—were applied as usual. The patient was discharged from the day surgery unit after at least 6 hours, in the absence of clinical or radiological complications (Figs. 5B and 7C).

After discharge, telemedicine consults and home visits were alternated for the postoperative follow-up. The home visits for clinical assessment were routinely performed by both the nurse and the physician staff from the HaH unit. The telemedicine consults were done by telephone and video calls. In addition, the patient was provided with a tablet and basic hardware for self-assessment of vitals every 8 hours to keep a record. If abnormal vitals were detected, the patient was instructed to call the HaH on-call staff. Because of the COVID-19 pandemic, telemedicine visits became more important. During the pilot study, no patients needed to be transferred to the hospital for further testing or admission.

<table>
<thead>
<tr>
<th>TABLE 1. OON protocol inclusion and exclusion criteria</th>
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<tr>
<td><strong>Inclusion criteria</strong></td>
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<tr>
<td>Supratentorial tumor</td>
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<tr>
<td>Stereotactic biopsy or craniotomy for biopsy or tumor resection of lesions &lt;3 cm in diameter &amp; &lt;1.5 cm deep</td>
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<tr>
<td>Caregiver available</td>
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<tr>
<td>Patient staying &lt;30 mins away from hospital</td>
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<tr>
<td><strong>Exclusion criteria</strong></td>
</tr>
<tr>
<td>Already an inpatient</td>
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<tr>
<td>Significant cardiorespiratory comorbidity</td>
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<tr>
<td>Airway management concerns</td>
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<tr>
<td>Uncontrolled seizures &amp;/or poor neurological status</td>
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<tr>
<td>Surgical procedure duration &gt;4 hrs</td>
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<tr>
<td>Patient preference</td>
</tr>
<tr>
<td>Chronic comorbidity not satisfactorily controlled (HBP, DM, COPD, etc.)</td>
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COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; HBP = high blood pressure.

FIG. 1. OON protocol flowchart for preoperative assessment. LE = surgery waiting list; SD = surgery day.
**FIG. 2.** OON protocol flowchart for same-day-discharge surgical procedure (SP). DSU = day surgery unit; IQ = surgical intervention; NSAIDs = nonsteroidal anti-inflammatory drugs.

**FIG. 3.** OON protocol flowchart for postoperative follow-up. q8 = every 8 hours.
Barriers to Implementation of the OON Program
Healthcare Provider Preferences

Several participants from the different departments often preferred the in-hospital protocols. This was more noticeable among neurosurgeons and anesthesiologists, who already had well-established and time-tested protocols for neurosurgical care but lacked experience in outpatient neurosurgery. Regarding the anesthetic procedure, some
Mora et al. preferred invasive monitoring, including arterial and central venous lines and urinary catheters, over noninvasive techniques. Similarly, some neurosurgeons leaned toward in-hospital perioperative care, especially when the patient’s diagnosis took place in the emergency department and direct admission was common practice.

Patient Reluctance to Undergo Surgery as an Outpatient

Several eligible patients preferred to be treated according to the in-hospital protocol of perioperative care. In most cases, this was motivated by the fear of the patient or the patient’s family of not being in the hospital if postoperative complications arose. Furthermore, all of the patients were surprised that a neurosurgical procedure could be performed on an outpatient basis.

Geographic Limitation of the Eligible Population

The limits on the geographic area covered by the HaH unit reduced the population that could be eligible for enrollment in the OON protocol. Although the neurosurgery and anesthesiology units provide neurosurgical care for a wider geographic area, patients living outside the area covered by the HaH unit were not offered the possibility of undergoing an outpatient procedure.

Barriers of Telemedicine in Brain Tumor Surgery Patients

The telemedicine strategies provided limited assessment of the neurological status. Moreover, the distance postoperative follow-up required telemedicine equipment, which was sometimes a barrier for geriatric patients lacking basic informatics knowledge. This problem was always overcome with the involvement of the patient’s family and caregivers.

Other minor barriers included a lack of experience in neurosurgical perioperative care from some participants, which was overcome by providing dedicated training on OON. In addition, the lack of specific funding prevented us from creating a position for a specialist nurse program coordinator—an uncommon figure in the Spanish healthcare system—who could have acted as a link among all the units and who could have coordinated follow-up of the patient in all stages of the protocol.

Facilitators of Implementation of the OON Program

Multidisciplinary Team Approach

The expertise of each member of the team helped to enrich the OON protocol design and implementation, resulting in a comprehensive perioperative care protocol. In addition, a multidisciplinary approach counteracted the lack of experience of some members of the group via the expertise of others. Moreover, patient-centered close cooperation and communication among the team members were essential, and all members of the team were always aware of the OON protocol steps completed by each patient in real time.

HaH Unit

The HaH unit was one of the main factors that helped to overcome some of the barriers identified during implementation of the protocol. The HaH unit is well known among the public, as it was one of the first of its kind in the country. Moreover, it had a decisive role in assessing a patient’s sociodemographic context and in providing patient education. In addition, these units oversaw postoperative care at home, including the telemedicine consults, which were directly responsible for pain management and postoperative complication prevention, assessment, and treatment. For both healthcare providers and patients, the HaH unit acted as a safety net for complications since it ensured close monitoring of patients at home while profiting from the advantages of an outpatient procedure.

Telemedicine Strategies

The telemedicine strategies used were essential tools for monitoring these patients. The telephone and video calls allowed remote follow-up and reassured patients and caregivers during postoperative care. Because of the telemedicine visits, patient care was achieved from the comfort of patients’ homes, allowing close postoperative monitoring while reducing the total time of appointments. Moreover, telemedicine facilitated access for people with disabilities, who have difficulty with transportation to hospitals, and it reduced the caregiver’s loss of productivity during the appointment. Patients and family members agreed to the

FIG. 5. Case 1. Preoperative MRI showed a contrast-enhancing lesion in the left parietal lobe, as depicted on an axial T1-weighted sequence with gadolinium (A). Postoperative CT scan obtained 6 hours after the procedure, showing the surgical cavity (B); there were no signs of postoperative complications. The HaH staff conducted the programmed visits at home and the telehealth consults, and the postoperative course was uneventful with adequate pain control, no postoperative neurological deficit, appropriate wound healing, and no medical complications. Three-month postoperative MRI showed the surgical cavity with scarring changes, as depicted on an axial T1-weighted sequence with gadolinium (C).
use of such strategies and were satisfied. Given the development and expansion of new technologies, there were no problems in contacting patients by both telephone and videoconference.

Identifying Key Individuals
Several individuals from the clinical departments involved in the protocol, including participants who were not members of the OON team, proved to be essential in the implementation of the protocol. They actively recruited patients, adopted the new standardization dictated by the protocol, and provided valuable feedback for continuous process improvement.

Protocol Intrinsic Factors
Two main factors inherent to the protocol itself sig-
The development of a simple protocol, including unambiguous criteria for patient selection, was essential to achieve standardization of the process among the different units. It also allowed team members to become empowered during the implementation phase. Furthermore, the strategies for patient education allowed patients to comprehend the process, helping them to realize the potential benefits of an outpatient procedure. This, in turn, resulted in highly motivated patients and primary caregivers.

Collaboration With Experienced Centers

The collaboration with an experienced center in the field allowed some members of the OON team to receive specific training in outpatient neurosurgery and enabled distant assistance by senior colleagues with extensive experience. These two factors resulted in a significant shortcut in the design and implementation phases, as they helped to avoid unnecessary steps and known common mistakes.

Discussion

OON: Current State of Development

Currently, in hospital management policies, there is a clear tendency toward an increase in outpatient perioperative care,18,19 and several surgical specialties are not strangers to this trend.1 In neurosurgery, however, the rise in outpatient procedures mainly occurs in spine surgery, which has increasingly been performed on an outpatient basis,20 with little or no representation in other neurosurgical subspecialties. OON is not an exception; although it was first described 2 decades ago in Toronto—with an initial protocol success rate of 89%7 and numerous reports proving its feasibility, safety, and advantages2–4,6–8,11—it is not routinely applied at other centers, with a few exceptions.5,10,21

For instance, the Toronto OON protocol was implemented at one center in the United Kingdom (UK).4 Results in the UK, including those for 30 stereotactic biopsies and 11 craniotomies for tumor, showed that the protocol can be successfully adopted in a different healthcare system.

TABLE 2. Barriers and facilitators in establishing an OON program

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
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<tbody>
<tr>
<td>Barrier</td>
<td>Preference for in-hospital protocols by some participants in OON program</td>
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<tr>
<td>Healthcare provider preferences</td>
<td>Some eligible patients preferred to be treated according to in-hospital protocols</td>
</tr>
<tr>
<td>Patient reluctance</td>
<td>Limits on geographic area covered by HaH unit reduced potentially eligible population</td>
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<tr>
<td>Geographic limitation of eligible population</td>
<td></td>
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<tr>
<td>Facilitator</td>
<td>OON team included neurosurgeons, anesthesiologists, physicians &amp; nurses from HaH units, &amp; management specialist</td>
</tr>
<tr>
<td>Multidisciplinary team approach</td>
<td>HaH oversaw patients’ postop care at home</td>
</tr>
<tr>
<td>Identifying key individuals</td>
<td>Specific individuals involved in OON program actively participated in implementation process by recruiting patients &amp; adopting new standardization dictated by protocol</td>
</tr>
<tr>
<td>Protocol intrinsic factors</td>
<td>Simplicity of protocol &amp; strategies for patient education significantly enabled program implementation &amp; development</td>
</tr>
<tr>
<td>Collaboration w/ experienced centers</td>
<td>Included on-site specific training on OON &amp; distant assistance by senior colleagues</td>
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with similar outcome and safety rates. Other than this example, and to the best of our knowledge, there are no other published descriptions on the design and implementation of an OON program in a European clinical setting. Furthermore, the barriers and facilitators that an oncological neurosurgery unit in a particular healthcare system may face during program implementation remain unknown.

A comprehensive review on the feasibility of developing an OON program in India indicated that several socioeconomic, medicolegal, and ethical factors may have a significant impact on implementing such a program. Although some of these factors can certainly be extrapolated to other countries and healthcare facilities, the nuances in each one may positively or negatively influence successful implementation of the program. Furthermore, some factors hindering the process may explain why OON is not adopted as a common practice by the neurosurgical community.

The modest development of OON in European clinical settings stands in stark contrast to the supportive evidence on clinical outcomes and safety. Despite the lack of randomized clinical trials demonstrating the superiority of outpatient over inpatient protocols in terms of clinical outcomes, the results published to date have proved that no patient has experienced a negative outcome because of early discharge. Furthermore, early discharge can avoid complications arising from hospitalization, such as nosocomial infections, thromboembolism, and the possibility of iatrogenesis. Moreover, qualitative studies have shown that it is a procedure well tolerated by the patient as well as the family and has a positive impact on the patient’s perception of disease.

Considering the OON advantages, it is important to identify both the main barriers and the principal facilitators that may influence the development of a telemedicine-based program in a particular oncological neurosurgery unit as a crucial step in overcoming the former and maximizing the latter.

**Barriers and Facilitators of OON Implantation**

In the UK cohort, although the protocol was comprehensively described, an analysis regarding the factors influencing the implementation process was not included. However, some barriers to patient recruitment due to operating room list schedules may be inferred from the fact that eligible patients undergoing surgery in the afternoon could not be included in the protocol. In fact, the proportion of patients undergoing outpatient craniotomy for tumor resection in Toronto was double that of the patients in the UK cohort. This illustrates how some external factors may hinder initiation of an OON program in a particular setting. Moreover, the importance of regional and local variability in the organization of neurosurgical departments has been recognized as an important factor influencing the implementation of an OON program.

In our experience, three barriers—healthcare provider preference, patient reluctance, and geographic limitations—negatively impacted the patient recruitment process. The healthcare provider preferences for in-hospital surgery and the lack of reliance on OON protocols have been previously recognized in the general neurosurgery community. Several factors have been hypothesized to contribute to this problem, including medicolegal and ethical issues. For instance, a diversity of opinions exists for minimally invasive monitoring in neurosurgery. While the procedure has been routinely used with good results in the Toronto protocol, it has not been standard care in our country and still entails some controversy.

Regarding patient reluctance to undergo OON, our patients’ first reactions to an outpatient procedure were similar to those described by Khu et al. in a study analyzing patient perceptions of OON. Ultimately, however, they trusted the system and very few of them insisted on having inpatient care.

On the other hand, several facilitators helped to partially counterbalance these barriers. Among them, telemedicine was one of the most important and its impact is described in a specific section below. Among the other facilitators, the identification of key individuals within each department who were agreeable to embracing and promoting implementation of the OON protocol progressively helped to reduce the impact of some healthcare providers’ preference for inpatient methods. In the same way, patient education significantly helped to minimize patient reluctance to accept OON. Frequently, after receiving appropriate information on the process and its beneficial aspects, patients agreed to be enrolled in the program, which is similar to what has been described in previous reports.

A multidisciplinary team approach was also a crucial factor in the development of the program. In fact, the Toronto protocol requires close coordination among several units and healthcare providers, including the neurosurgeon, the anesthesiologists, and the nurses at the day surgery unit. For instance, in our experience, the anesthesiologist’s role in recognizing potential complications in patients with risk factors allowed the team to be prepared and improve patient selection. Similarly, aside from their educational role, nurses became one of the closest contacts of the patients as they established fluid communication with them, enabling prompt responses to patient needs.

Furthermore, our protocol is characterized by incorporating the HaH unit in the OON process. Home hospitalization programs have become an innovative solution to deal with increases in population age and chronic disease. Moreover, it has been suggested that HaH may be superior to inpatient care in terms of cost savings and clinical outcome, although these observations have not been fully validated by recent meta-analyses. Moreover, HaH-based surgery is emerging as a more efficient alternative to in-hospital postoperative care and there are a few limited experiences of perioperative care in HaH units in complex colorectal surgery, total hip replacement, and coronary artery bypass. Nonetheless, to the best of our knowledge, there have been no previous experiences in neurosurgical HaH-based perioperative care. In our case, the HaH program’s previous experience in perioperative care in other surgical fields was highly valuable in developing our protocol. However, the clinical and economic outcomes of HaH-based perioperative care in OON remain unclear, and further research is warranted to reach solid conclusions.
Finally, collaboration with a center with worldwide experience in the field provided the local team with practical tools for the implementation process and allowed them to avoid unnecessary steps. In addition, it is remarkable that, to the best of our knowledge, all the initiatives of OON implementation worldwide have applied the Toronto protocol after undergoing on-site specific training. This certainly highlights the importance of specific training in the field and guidance from a more experienced team when initiating an OON program.

**Telemedicine in Neuro-Oncological Patients**

As one of the facilitators identified, telemedicine seems to be gaining importance in recent years with the development of new technologies. Already, there are several descriptions of the applications of telemedicine for perioperative care, and it is considered by some to be one of the major hallmarks of patient care in the near future. Furthermore, high satisfaction with telemedicine, by both providers and patients, is promising in terms of the future expansion of telehealth. For instance, using telemedicine in our practice greatly helped to protect both patients and staff and to reduce the transmission of COVID-19 during the pandemic.

Additionally, the convenience of monitoring from home reduces the waiting time and loss of productivity of the caregiver, as well as the cost of transportation. Moreover, previous studies have validated neurological examination in telemedicine. Therefore, telemedicine strategies enable real-time telemonitoring of the patient at home and partially replace in-person visits with teleconferences. Thus, its increasing application in OON may be a matter of time.

**Study Limitations**

The small number of patients included in the study prevented us from reaching conclusions on clinical outcome, complications, economic analysis, or patient satisfaction, and doing so was not included in the objectives of the current analysis.

**Conclusions**

Initiating an OON program with telemedicine-based follow-up in a European clinical setting is feasible, and the experience presented here may add to previous evidence on safety and clinical outcome to encourage the progressive development of tailored OON programs in other oncological neurosurgery units. Nevertheless, such programs pose several barriers including healthcare provider resistance to change, patient reluctance to undergo an outpatient procedure, lack of experience in outpatient neurosurgery, and limitations in the recruitment of eligible patients. These barriers can be overcome by identifying and maximizing key facilitators of the process, such as patient education and a multidisciplinary team approach, which are crucial for the success of the program. Moreover, HaH-based perioperative care was shown to be one of the most important factors in the development and implementation of the program. Future studies should investigate the cost-effectiveness of telemedicine to assess both potential cost savings through reducing travel and wait times and the impact on patient satisfaction.

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**References**


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Supplemental Information
Videos

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