Preferences and Utilities for Health States after Treatment of Olfactory Groove Meningioma: Endoscopic versus Open

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Abstract

Objectives The purpose of this study is to report health utility scores for patients with olfactory groove meningiomas (OGM) treated with either the standard transcranial approach, or the expanded endonasal endoscopic approach.

Design The time trade-off technique was used to derive health utility scores.

Setting Healthy individuals without skull base tumors were surveyed.

Main Outcome Measures Participants reviewed and rated scenarios describing treatment (endoscopic, open, stereotactic radiation, watchful waiting), remission, recurrence, and complications associated with the management of OGMs.

Results There were 51 participants. The endoscopic approach was associated with higher utility scores compared with an open craniotomy approach (0.88 vs. 0.74; $p < 0.001$) and watchful waiting (0.88 vs. 0.74; $p = 0.002$). If recurrence occurred, revision endoscopic resection continued to have a higher utility score compared with revision open craniotomy (0.68; $p = 0.008$). On multivariate analysis, older individuals were more likely to opt for watchful waiting ($p = 0.001$), whereas participants from higher income brackets were more likely to rate stereotactic radiosurgery with higher utility scores ($p = 0.017$).

Conclusion The endoscopic approach was associated with higher utility scores than craniotomy for primary and revision cases. The present utilities can be used for future cost-utility analyses.

Keywords

- ▶ health utility scores
- ▶ time trade-off
- ▶ olfactory groove meningioma
- ▶ expanded endonasal approach
- ▶ quality of life

Introduction

Olfactory groove meningiomas (OGMs) and their treatment may significantly impact patients' quality of life (QOL) and neurocognitive function.^{1–10} For symptomatic patients, the treatment is typically surgical excision. These lesions may be resected by a variety of approaches including transcranial

approaches, such as bifrontal, pterional, and frontolateral craniotomies, or, more recently, by expanded endoscopic endonasal approaches. Although the precise indications for this approach may depend on size, the extent of dural involvement, their relationship to critical vascular and neural structures, and surgeon's preference and comfort level, one

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proposed advantage of this approach is the avoidance of brain retraction and frontal lobe injury.¹¹ The downstream QOL impact of the open versus endoscopic approach, however, is still unknown.

With the advent of newer surgical approaches to these lesions, the impact of surgical approach on patients' QOL has become increasingly important. This concept may be challenging to measure, representing a multidimensional construct encompassing a patient's perception of their overall well-being and physical/psychosocial health in the context of their environment. Health-related QOL instruments that measure QOL for anterior skull base pathology include the Anterior Skull Base Questionnaire and the Skull Base Inventory.^{12–15}

Health state utilities are values that reflect an individual's preference for given health states. These scores are typically on a continuum from 0 to 1.0, where 0 represents death or a state worse than death and 1.0 represents the best possible health.¹⁶ Utilities are used in medical decision-making as a valuation of QOL for a given health state. They are often used to weigh one's life expectancy based on their QOL to generate a measure known as quality-adjusted life expectancy measured in quality-adjusted life years. Health state utilities are used in health economic analyses comparing the impact of new treatments in terms of both resource implications and the general effectiveness of those new treatments. With the advent of the endoscopic endonasal approach in the management of OGMs, future cost-effectiveness analyses comparing this approach with standard approaches are predicated on the acquisition of utilities of health states following treatment.

In the present study, we use the time trade-off (TTO) technique,^{17–20} a commonly used direct measure of health utilities to derive health utilities for various health states associated with OGMs. Specifically, the preferences and utilities for an endoscopic resection of OGMs were compared with other treatment approaches.

Methodology

Scenarios

Twenty scenarios describing relevant health states after diagnosis of an OGM were created. Scenarios were subsequently reviewed independently for content accuracy and interpretability by the senior authors (►Appendix). Scenarios were categorized as treatment-related, relapse-related, and complications. Treatment-related scenarios described symptoms associated with the condition, the process of undergoing a proposed treatment with its associated morbidities. There was one scenario for each of the following treatment paradigms: watchful waiting, endoscopic resection, open bifrontal craniotomy resection, and stereotactic radiation. Recurrence-related scenarios captured the type of recurrence and its associated treatment and morbidity. Complication-related scenarios described the common complications and their associated morbidity. Each scenario provided the participants with a description of the health state, the duration that one would likely spend in that state, the impact on daily living, physical limitations, and living with the uncertainty of recurrence.

Healthy Participants

The study was approved by the University Health Network Research Review Board. In total, 51 healthy participants were recruited from a general clinic once the following criteria were met: (1) over the age of 18, (2) English speaking, (3) no history of anterior skull base lesions, and (4) no physicians. Participants were asked to participate in a 30- to 45-minute interview with a trained research assistant (A. K.). They were then asked to complete a demographic questionnaire prior to completing the TTO exercise to acquire utilities based on each health state scenario. Participants were given the opportunity to read through each scenario and ask questions of clarification to the research assistant. The demographics questionnaire collected information including age, sex, race, education level, and annual household income.

Utilities

The TTO technique was employed to derive health state utilities for each health scenario. Participants were asked to choose between two alternatives (►Supplementary Data): living 20 years in a given health state or sacrificing (*t*) years of life to be completely relieved from the health problem and to be completely healthy.

Analysis

The median utility scores were calculated for each of the 20 scenarios with 95% confidence intervals. The Kolmogorov-Smirnov test was used for normality. Although all utility scores were normally distributed, most health utility studies demonstrate a nonparametric sample. As such, both nonparametric tests and parametric tests were used for TTO utilities.

Treatment-related utilities were compared in a pairwise fashion. TTO utilities were compared using the Mann-Whitney U test and the independent *t*-test. Univariate and multivariate analysis were performed to analyze TTO utility score variability based on participant demographics (age, sex, race, education level, and household income). Based on prior studies by our group, a sample size of 50 was deemed adequate to determine utility scores with a confidence interval of ± 0.01 . As such, this was deemed a necessary sample size for utility determination.

Results

Participants

In this study, there were 51 healthy participants. The mean age was 48.9 (standard deviation: 16.5; range: 19–77). Of the 51 participants, 22 were men and 29 were women. Forty-one participants were Caucasian, with the remaining 10 participants consisting of Asians ($n = 7$), African ($n = 1$), Native-American ($n = 1$), and other ($n = 1$). The majority of our participants completed a college degree ($n = 24$) and have an annual household income either between \$80 and 99,999 CAD ($n = 15$) or between \$100 and 249,999 ($n = 14$), indicating representation from different social economic classes. The rest of the demographic information can be found in ►Table 1.

Table 1 Demographics of participants

Age	48.9
Sex	
Male	22 (43%)
Female	29 (57%)
Race	
White	41 (80%)
Asia	6 (12%)
African Canadian	1 (2%)
South Asian	1 (2%)
Native American	1 (2%)
Other	1 (2%)
Education	
Did not finish high school	1 (2%)
High school	7 (14%)
College	24 (47%)
Postgraduate	19 (37%)
Annual household income	
<\$20,000	4 (8%)
\$20–39,999	5 (10%)
\$40–59,999	6 (12%)
\$60–79,999	4 (8%)
\$80–99,999	15 (29%)
\$100–249,999	14 (27%)
>\$250,000	2 (4%)
Missing	1 (2%)
VAS	78.9
0–9	0
10–19	0
20–29	0
30–39	0
40–49	1 (2%)
50–59	1 (2%)
60–69	7 (14%)
70–79	10 (20%)
80–89	14 (27%)
90–100	18 (35%)

Abbreviations: VAS, visual analog scale.

Utilities for Treatment of Olfactory Groove Meningioma

Four treatment strategies for the management of OGMs were presented, including endoscopic resection, open craniotomy resection, stereotactic radiation, and watchful waiting (►Table 2). Stereotactic radiation had the highest health utility score (0.92) among healthy participants, followed by endoscopic resection (0.88), watchful waiting (0.74), and open craniotomy (0.74) among healthy participants. Stereo-

Table 2 Treatment scenarios and derived health utilities

	Healthy participants	Range
Watchful waiting	0.74	(0.1–1)
Endoscopic resection	0.88	(0.5–1)
Craniotomy	0.74	(0.1–1)
Stereotactic radiation	0.92	(0.5–1)

tactic radiation had significantly higher health utility scores than all other treatment modalities (►Table 3). Endoscopic resection also had a significantly higher health utility score than open craniotomy ($p = 0.000$) and watchful waiting ($p = 0.002$), but had a lower health utility score than stereotactic radiation ($p = 0.043$). There was no significant difference between utility scores for watchful waiting compared with open craniotomy for the treatment of OGM ($p = 0.645$).

Utilities for Recurrence with Associated Treatments

Four recurrence scenarios with local recurrence being managed by revision endoscopic, revision open craniotomy, stereotactic radiation, and observation were presented (►Table 4). Local recurrence treated with stereotactic radiation had the highest health utility score (0.87) among healthy participants, followed by treatment with endoscopic resection (0.79) and observation (0.73). Local recurrence treated with revision craniotomy had the lowest health utility score (0.68). In recurrence scenarios, management with stereotactic radiation had a health utility score significantly higher than all other treatment modalities (►Table 5), whereas endoscopic resection had a health utility score significantly higher than open craniotomy. Treatment of recurrence with open craniotomy and watchful waiting did not significantly differ in their health utility score.

The health utility score was higher for primary endoscopic resection compared with endoscopic resection of local recurrence ($p = 0.028$). Otherwise, the health utility scores did not differ largely between watchful waiting, open craniotomy, and stereotactic radiation for primary treatment versus local recurrence (►Table 5).

Utilities for Complications after Treatment

Complications associated with the treatment of OGMs had low health utility scores among healthy participants (►Table 6). The highest health utility score was given to an acute sinus infection sustained near the time of treatment (0.92), whereas a stroke complicating the treatment was associated with the lowest health utility score (0.49).

Univariate and Multivariate Analysis of TTO Utility Scores for Treatment by Demographics

Among healthy participants, health utility scores for each treatment modality of primary OGMs were analyzed for any demographic subgroup variability using univariate and multivariate analyses. In univariate analysis, utility scores for endoscopic resection varied by education ($p = 0.045$). Participants who had completed higher levels of education were more likely to rate endoscopic resection with higher health

Table 3 Paired comparison of treatment scenarios

	Comparison of respective means	p-Value (Mann–Whitney U test)
Watchful waiting vs. endoscopic	0.74 vs. 0.88	0.002
Watchful waiting vs. craniotomy	0.74 vs. 0.74	0.645
Watchful waiting vs. stereotactic radiation	0.74 vs. 0.92	0.000
Endoscopic vs. craniotomy	0.88 vs. 0.74	0.000
Endoscopic vs. stereotactic radiation	0.88 vs. 0.92	0.043
Stereotactic radiation vs. craniotomy	0.92 vs. 0.74	0.000

Table 4 Remission and recurrence scenarios and derived health utilities

	Healthy participants	Range
Local recurrence with revision endoscopic approach	0.79	(0.1–1)
Local recurrence with craniotomy	0.68	(0.1–1)
Failure of resection requiring stereotactic radiation	0.87	(0.1–1)
Local recurrence with watchful waiting	0.73	(0.1–1)

utility scores. Utilities did not otherwise vary by age, sex, race, or income level on univariate analysis.

In multivariate analysis, age was associated with higher health utility scores for watchful waiting ($p = 0.001$). Furthermore, participants from higher income brackets were more likely to score stereotactic radiation with higher health utilities scores ($p = 0.017$).

Discussion

OGMs account for 8 to 13% of all intracranial meningiomas. For OGMs requiring treatment, options include surgery, and stereotactic radiation, with surgical management of this tumor evolving from craniotomy approaches including bifrontal, unilateral sub frontal, or pterional to fully endoscopic resection. Each treatment approach has an inherent spectrum of morbidity that may affect patients' QOL. In the present study, we describe the health state utilities derived for various health states associated with the treatment of OGMs. The utility scores derived in the present study may be used for future cost-effectiveness analyses comparing surgical approaches. Health

utility scores approaching 1.0 denote QOL estimate closest to perfect health, whereas health utility scores approaching 0 denote QOL estimates considered at or worse than death.¹⁹

In our study, 20 scenarios were developed and vetted by experienced surgeons representing specialties managing OGMs to ensure accuracy. All treatment modalities were associated with disutility compared with full health. Our study suggests that patient significantly ascribed greater utility scores to both stereotactic radiosurgery and endoscopic resection compared with open craniotomy and watchful waiting. Overall, endoscopic resection was preferred to open craniotomy approaches.

The health utility scores derived from our study are congruent with previous QOL studies demonstrating that QOL may worsen in as many as 26 to 63% of patients after anterior skull base surgery.^{21,22} Previous long-term studies of QOL following open craniotomy approaches demonstrated 89% of patients with complaints of cosmesis and another 63% of patients with an overall dissatisfaction of their overall current status.²¹ In endoscopic resection, there may be a greater disruption of sinonasal anatomy and function,

Table 5 Paired comparisons of remission and recurrence scenarios

	Comparison of respective means	p-Value (t-test)	p-value (Mann–Whitney U test)
Local recurrence with revision endoscopic approach vs. local recurrence with craniotomy approach	0.79 vs. 0.68	0.016	0.008
Local recurrence with revision endoscopic approach vs. stereotactic radiation	0.79 vs. 0.87	0.077	0.013
Local recurrence with revision endoscopic approach vs. watchful waiting	0.79 vs. 0.73	0.154	0.164
Local recurrence with craniotomy vs. stereotactic radiation	0.68 vs. 0.87	0.000	0.000
Local recurrence with craniotomy approach vs. watchful waiting	0.68 vs. 0.73	0.374	0.292
Stereotactic radiation vs. watchful waiting	0.87 vs. 0.73	0.003	0.000

Table 6 Health state scenarios of complications and derived health utility scores

	Healthy participants	Range
CSF leak	0.66	(0.1–1)
Meningitis	0.66	(0.1–1)
brain abscess	0.61	(0.1–1)
Pulmonary embolism	0.75	(0.6–1)
Sinusitis	0.92	(0.1–1)
Stroke	0.49	(0.2–1)
Anosmia	0.87	(0.2–1)
Visual defect	0.77	(0.2–1)
Visual loss	0.82	(0.2–1)
Headache	0.75	(0.1–1)
Hydrocephalus	0.54	(0.1–1)
Seizure	0.67	(0.1–1)

Abbreviation: CSF, cerebrospinal fluid.

although this appears to be temporary, with majority of patients reporting very good QOL by 6 months.^{1,3,10} Comparing the two approaches also suggested that open approaches had a more significant impact on the QOL of patients in the physical function and emotional domains.²³

The utility score associated with stereotactic radiosurgery was the highest of all the treatment options, suggesting that the general public would prefer this approach. Patients cited the possibility of less than 24 hr hospital stay, preservation of olfaction, and good tumour control rates as factors contributing to their references.²⁴ Functional impairments associated with stereotactic radiation include fatigue, throat discomfort, xerostomia, and skin desquamation among others.²⁴ What we have not captured in the present study however, is the use of fractionated radiation. The delivery of multiple fractions of radiation would potentially result in a lower utility score, but for simplicity in the present study, the vignette associated with radiosurgery describes only the delivery of a single fraction of radiation. In a similar pattern to endoscopic resection, QOL studies have demonstrated that after radiation therapy, QOL scores declined at the 6-month interval but recovered to baseline scores by the 2-year interval, suggesting a “depressive phase, recovery phase, and normalization phase.”⁷ Individual health utility scores for health states associated with radiation were not derived in this study, as they are well elucidated in literature.^{7,24–27}

In our study, patients who developed recurrence continued to prefer endoscopic resection compared with open craniotomy approaches. This finding serves as an internal validation of the comprehension of the vignettes used to derive utility scores. Stereotactic radiation continued to be associated with higher health utility than endoscopic resection, watchful waiting, and open craniotomy for the treatment of recurrences. To simplify our health states, we focused on recurrences occurring after 10 years, in which case stereotactic radiation remains a treatment option. Interestingly, the health utility scores in recurrence scenarios were not significantly lower than those of primary scenarios reflecting an

attitude among the study participants that it is really the treatment itself that is associated with the disutility and not the number of times the treatment is administered. This is in keeping with studies in patients requiring re-irradiation for recurrences, where QOL scores were not significantly different following repeated treatment compared with baseline.²⁶

The low utility scores for watchful waiting in both primary and recurrence scenarios may reflect either the impact on patients’ psychological health with the knowledge of having a benign growth, fear of recurrence, or an inherent bias with the TTO methodology when compared with treatment scenarios.²⁸ In our study, we attempted to curtail the inherent bias by having a trained research interviewer ensure watchful waiting as a viable choice in the management of OGMs. However, the low utility scores for watchful waiting are supported by literature, where this psychological burden is often referred to as fear of cancer recurrence or progression (FCR). In several analyses of FCR, up to 67% of patients continue to have moderate, and 17.1% have severe debilitating fear one year following diagnosis.²⁷ FCR tends to affect younger patients and remains fairly stable during the evolution of cancer care.^{29–31}

There is a relative scarcity of literature related to utilities of complications related to treatment of OGMs. Previous studies have reported utilities after stroke ranging from 0.5 to 0.7 for minor strokes and 0 to 0.3 for major strokes, which corroborates the findings of the present study.³² Furthermore, health utility scores approximating 0.30 for seizure, 0.77 for survivors of meningitis, and 0.47 to 0.78 for blindness have been described.^{33–36} For the most part, the findings in the present study generally corroborate available published utility scores. The utility associated with visual loss in the present study, however, was surprisingly high. In general, we attempted not to ascribe a duration of time spent in each health state as this is generally accounted for in cost-utility models.

In our univariate analysis, the only demographic variable correlating with a trend in higher health utility scoring was higher education. It is possible that patients with higher degrees of education have a more nuanced understanding or perhaps a better comprehension of the scenarios of the surgical procedures and potential risks, complications, and disutility associated compared with those with lower degrees of education. In our multivariate analysis, older patients were more likely to associate watchful waiting with higher health utility scores, perhaps indicating that younger individuals were more likely to opt for treatment compared with older individuals.

There are some limitations as common with most utility studies to our study. First, our study demographics is predominately well-educated, which may bias the utilities, as they may theoretically comprehend scenarios better than those with lower education. Second, depending on the interpretation of the scenario description, different health utility scores may be derived. By having a trained researcher conduct the interviews, we aimed to curtail this bias by having scenarios explained and in a uniform manner. Finally, although we described the temporal duration of a given health state associated with different complication scenarios, the perspective of the participant may affect the disutility ascribed to chronic versus acute complications.

Conclusion

Health utility scores provide a numerical value for the QOL for a given health state. In this study, we address a current gap in QOL literature by defining health utility scores for disutility associated with the treatment, recurrence, and complications associated with endoscopic resection of OGM and open craniotomy approaches. These utilities can be used for further cost-utility analyses.

Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Appendix

Health State Scenarios

Scenarios for derivation of utilities

Treatment scenarios	
Scenario 1	<p><i>Watchful waiting of olfactory groove meningioma (no treatment)</i></p> <p>Imagine you have a tumor growing in between the brain and the nose. This tumor is benign, but often grows. Symptoms associated with the tumor may potentially include loss of smell (usually), loss of vision in one or both eyes, and symptoms related to the size of the tumor, such as seizures, headache, behavioral changes (irritability, aggression, behavioral changes, agitation, change in mood, loss of concentration), and potentially hormone dysfunctions.</p> <p>Currently, you are told that you do not need treatment, as it is relatively small. You would, however, require ongoing physician follow-up and repeated scans every six months. You may have anxiety over having a diagnosis of a “brain tumor.”</p>
Scenario 2	<p><i>Endoscopic resection of olfactory groove meningioma</i></p> <p>Imagine you have a tumor growing in between the brain and the nose. This tumor is benign, but often has steady slow growth. You undergo an endoscopic surgery using small telescopes and instruments through your nose, where there is no incision or opening of the skull to remove the tumor. You are admitted to the hospital for 5–7 days after surgery and stay at home for roughly 2–3 weeks.</p> <p>After the surgery:</p> <ul style="list-style-type: none"> • You have lost your sense of smell and your sense of taste is not what it used to be. This impacts your ability to appreciate odors (both pleasant and unpleasant) and your ability to appreciate the foods you once enjoyed. • You have occasional foul-smelling crusting within the nose requiring saline irrigation twice a day that may also affect your social interactions. • You may feel tired but should be able to perform most activities a week after surgery. • After this, you may have ongoing concern regarding completeness of resection and recurrence and will need ongoing follow-up. Most preoperatively symptoms will have resolved.
Scenario 3	<p><i>Craniotomy for resection of olfactory groove meningioma</i></p> <p>Imagine you have a tumor growing in between the brain and the nose. This tumor is benign, but often has steady slow growth. You undergo an operation requiring a large incision on your scalp extending from ear to the other (like a crown) and removal of your skull bone to remove the tumor. Because of the surgical approach, brain tissue is often retracted to access the tumor. You are admitted to the hospital for 5–7 days after surgery and stay at home for roughly 2–3 weeks.</p> <p>After the surgery:</p> <ul style="list-style-type: none"> • You have a scar on your scalp from one ear to the other over the top of your scalp. • You have lost your sense of smell and your sense of taste is not what it used to be. This impacts your ability to appreciate odors (both pleasant and unpleasant) and your ability to appreciate the foods you once enjoyed. • You may experience some changes in your attention, concentration, short-term memory loss, or behavior postoperatively. • You may feel tired but should be able to perform most activities a week after surgery. • After this, you may have ongoing concern regarding completeness of resection and recurrence and will need ongoing follow-up. Most preoperative symptoms will have resolved.
Scenario 4	<p><i>Stereotactic radiation for olfactory groove meningioma</i></p> <p>Imagine you have a tumor growing in between the brain and the nose. This tumor is benign, but often grows slowly. Given its small size of <3 cm and is not close to the nerves to the eye, you qualify for radiosurgery. Despite the name, there is no surgery involved, rather there is a dose of stereotactic radiation administered in a single installment in one day.</p> <p>After the treatment:</p> <ul style="list-style-type: none"> • You may have some nausea and headache. • Your senses of smell and taste have not improved. • You may feel tired but should be able to perform most activities a week after surgery. • After this, you may have ongoing concern regarding completeness of resection and recurrence and will need ongoing follow-up. Most preoperative symptoms will have resolved.
Remission and recurrence scenarios	
Scenario 1	<p><i>Local recurrence requiring revision endoscopic surgery</i></p> <p>After completing treatment for olfactory groove meningioma and being free of disease, your doctor tells you that the tumor has returned. You may have symptoms including loss of smell, loss of vision, and symptoms related to the size of the tumor, such as seizures, headache, behavioral changes (irritability, agitation, loss of concentration), and potentially endocrine dysfunction. Given the size of the tumor and location of the tumor, this recurrence requires an endoscopic surgery with small telescopes and instruments through the nose. Because this</p>

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	<p>is a repeat operation, you are more anxious, and the surgery is more complicated. You are admitted to the hospital for 5–7 days after surgery and stay at home for roughly 2–3 weeks.</p> <p>After the surgery:</p> <ul style="list-style-type: none"> • You have lost your sense of smell and your sense of taste is not what it used to be. This impacts your ability to appreciate odors (both pleasant and unpleasant) and your ability to appreciate the foods you once enjoyed. • You have occasional foul-smelling crusting within the nose requiring saline irrigation twice a day that may also affect your social interactions. • You may feel tired but should be able to perform most activities a week after surgery. • After this, you may have ongoing concern regarding completeness of resection and recurrence and will need ongoing follow-up. Most preoperatively symptoms will have resolved.
Scenario 2	<p><i>Local recurrence requiring revision open craniotomy</i></p> <p>After completing treatment for olfactory groove meningioma and being free of disease, your doctor tells you that the tumor has returned. You may have symptoms including loss of smell, loss of vision, and symptoms related to the size of the tumor, such as seizures, headache, behavioral changes (irritability, agitation, loss of concentration), and potentially endocrine dysfunction. Given the size of the tumor and location of the tumor, this recurrence requires an operation with an incision over the top of your scalp (from ear to ear) and removal of the skull bone to access the tumor. Because this is a repeat operation, you are more anxious, and the surgery is more complicated. You are admitted to the hospital for 5–7 days after surgery and stay at home for roughly 2–3 weeks.</p> <p>After the surgery:</p> <ul style="list-style-type: none"> • You have a scar on your scalp from one ear to the other over the top of your scalp. • You have lost your sense of smell, and your sense of taste is not what it used to be. This impacts your ability to appreciate odors (both pleasant and unpleasant) and your ability to appreciate the foods you once enjoyed. • You may experience some changes in your attention, concentration, short-term memory loss, or behavior postoperatively. • You may feel tired but should be able to perform most activities a week after surgery. • After this, you may have ongoing concern regarding completeness of resection and recurrence and will need ongoing follow-up. Most preoperative symptoms will have resolved.
Scenario 3	<p><i>Failure of initial treatment, ongoing growth requiring stereotactic radiation</i></p> <p>After completing treatment for olfactory groove meningioma and being free of disease, your doctor tells you that the tumor is continuing to grow. You may have symptoms including loss of smell, loss of vision, and symptoms related to the size of the tumor, such as seizures, headache, behavioral changes (irritability, agitation, loss of concentration), and potentially endocrine dysfunction. This recurrence requires undergoing stereotactic radiation in a onetime application. Side effects are as in Scenario 2, with slightly higher risk of loss of smell.</p>
Scenario 4	<p><i>Local recurrence requiring watchful waiting</i></p> <p>After completing treatment for olfactory groove meningioma and being free of disease, your doctor tells you that the tumor has returned. You may have symptoms including loss of smell, loss of vision, and symptoms related to the size of the tumor, such as seizures, headache, behavioral changes (irritability, agitation, loss of concentration), and potentially endocrine dysfunction. Currently, you are told that you do not need any treatment, as it is relatively small. You do, however, need ongoing physician follow-up and repeated scans every 6 months. You have ongoing anxiety over having a “brain tumor” that you contend with on a daily basis.</p>
Complication scenarios	
Scenario 1	<p><i>Brain fluid (cerebrospinal) leakage</i></p> <p>You are treated for an olfactory groove meningioma. After surgery, you experience leakage of brain fluid through nose. A clear fluid drips out of your nose, and when it falls backward, there is a sweet or salty metallic taste to it. This is inconvenient as any exertion may worsen the dripping of your nose. You are required to be on bed rest, straining precautions, and even have a placement of a drain in the spine. You are also told that you have an increased risk of an infection to the lining of your brain called meningitis which can be life-threatening. You require revision surgery to repair the skull base. After revision surgical management, the clear fluid drainage stops, but for a period of several weeks, you are still asked not to exert yourself and/or avoid heavy lifting.</p>
Scenario 2	<p><i>Meningitis</i></p> <p>After surgery for your olfactory groove meningioma, you develop a fever, neck stiffness, a headache, and altered level of consciousness. You have a spinal tap procedure and are told that you have an infection in the lining of your brain (meningitis). This episode requires aggressive intravenous antibiotics and maybe life-threatening.</p>
Scenario 3	<p><i>Brain abscess</i></p> <p>After surgery, you develop an infection in your brain. This infection affects your level of consciousness and requires surgical drainage as well as antibiotics. You may be left with some residual deficits particularly with regard to cognitive function such as concentration, attention, memory loss, and possibly behavioral changes. This infection may also be life-threatening.</p>
Scenario 4	<p><i>Pulmonary embolism</i></p> <p>You are treated with surgery for an olfactory groove meningioma. After surgery, you experience shortness of breath, tachycardia, and potentially chest pain with deep inspiration. You undergo a CT scan, which reveals a clot</p>

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	in the lung and you are required to take blood thinners. You are at a higher risk of bleeding from the surgical site. You leave the hospital taking blood thinners and are closely followed with the thrombosis clinic every 2–3 weeks. While on blood thinners you are at increased risk of bleeding. The blood thinners are often required for several months, and the shortness of breath takes time to improve (days to weeks).
Scenario 5	<i>Sinus infection</i> You undergo an operation for an olfactory groove meningioma. After treatment, you experience pain and pressure over your sinuses, a headache, nasal blockage, and foul-smelling discharge from the nose. This episode takes several days to resolve with antibiotics and nasal rinses. Following medical treatment, there are no longer any complications and you return to normal daily activities.
Scenario 6	<i>Stroke</i> You are treated for an olfactory groove meningioma with surgery. Following surgery, you suffer a stroke as a complication, which results in paralysis of one side of your body. The stroke affects your ability to use your arm and leg on one side of your body. You require physiotherapy to help with rehabilitation. You also have difficulties with speech and swallowing that require therapy to help regain this function. The deficits may improve, but there is a long course of rehabilitation. You require some time spent in a rehabilitation facility and modifications to your previous way of living, including at work and at home to accommodate these new deficits.
Scenario 7	<i>Loss of sense of smell</i> You are treated for an olfactory groove meningioma with an endoscopic resection through the nose. Following the operation, you notice that you have a deficiency in your sense of smell and taste. It affects the way you enjoy food, and there is a safety concern as you cannot smell things such as smoke. Although you are otherwise well, you cannot enjoy food the way you used to and this may have an impact on social eating.
Scenario 8	<i>Visual defect</i> You are treated for an olfactory groove meningioma with surgery. Following the operation, you notice that you have blurry vision and a decrease in visual acuity. You also notice that colors may be less vibrant to you. There is a safety risk, and you may no longer be able to operate a vehicle. Although you are otherwise well, you are told that your vision may not recover.
Scenario 9	<i>Visual loss</i> You are treated for an olfactory groove meningioma with surgery. Following the operation, you notice that you have loss of vision in one eye. Your depth perception is now affected. You may no longer be able to operate a vehicle; however, you are otherwise able to maintain most of your daily activities with minor adjustments.
Scenario 10	<i>Headache</i> You are treated for an olfactory groove meningioma with surgery. Following the operation, you notice that you have ongoing tension headache. Occasionally, you need to take over-the-counter medication to help you cope with the pain. Although you are otherwise well, you are told that although you may get used to the headache, and it becomes less aggravating, it may not completely dissipate.
Scenario 11	<i>Hydrocephalus</i> You are treated for an olfactory groove meningioma with surgery. Following the operation, you are told that you have hydrocephalus, which is an abnormal accumulation of brain fluid causing increased pressure in the skull band may result mental disability if not treated. You require an additional procedure to insert a shunt diverting excess CSF to drain into the peritoneal cavity in your abdomen. The shunt is tunneled under the skin and is required for the rest of your life. However, you are at risk of shunt complications including shunt malfunction (blocked), shunt failure, and shunt infections. You need ongoing follow-up and imaging.
Scenario 12	<i>Seizure</i> You are treated for an olfactory groove meningioma with surgery. Following the operation, you develop seizures. You require medications to control seizures. For the first 6 months following the operation, your driving license has been suspended. You require ongoing medications to prevent seizures. The seizures are associated with temporary loss of consciousness, convulsions, and may be life-threatening.

Abbreviations: CSF, cerebrospinal fluid; CT, computed tomography.