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Original Article

Neuro–oncology Burden in Developing Countries: A Retrospective Cost–Analysis Study

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Abstract

Background: Brain tumours are a significant economic burden on patients and health systems.

Objectives: This research aims to study the cost associated with management of brain tumour and its impact on healthcare.

Methods and material: This is a retrospective observational study involving 280 patients with brain tumours at the Neurosurgery Department at Khoula Hospital in Oman. Data on patient demographics, type of brain tumour, diagnosis, treatment, cost of imaging and laboratory investigations, and length of hospital stay were collected from medical records.

Results: The average cost of imaging and laboratory investigations was $276,293.33, with imaging accounting for $208,168.7 and laboratory tests accounting for $68,124.63. CT scan was the most expensive imaging investigation, followed by MRI and X–ray. RFT, MDR, and MRSA screening were the most expensive laboratory tests. The most common diagnosis was meningioma (18% of cases). The average length of hospital stay was 16 days.

Conclusion: The cost of brain tumour management in Oman is significant. Further research is needed to understand the full economic burden of brain tumour management in Oman, including the costs of surgical and non–surgical interventions.

Keywords: brain tumour, cost analysis, neurosurgery, Leave against medical advice, LAMA, Discharge Against Medical Advice, DAMA.

Introduction

Brain and Spinal cord tumors collectively refer to neoplasms originating from intracranial and meningeal tissues. Moreover, some could be metastasized to the brain from other tissues. With variations in stages of differentiation & malignancy, such tumors are clinically presented by seizures, headaches, fatigue, and cognitive dysfunction.[1] In the past 50 years, Brain tumors seem to be on the rise, and according to the World Health Organization (WHO), developed countries tend to have the highest incidence of brain tumors.[2] In Oman, according to Khoula Hospital's recent study, 9.6% of the 1419 admitted patients to the neurological department suffered from cranial and spinal tumors.[3] In the clinical management of Central Nervous system (CNS) tumors, surgery is one of the most common interventions that are being used, which mainly relies on neuropathological studies. Despite that, CNS surgeries encounter a massive challenge in the process of dissecting the tumor without damaging nearby tissues, therefore, causing more neurological damage.

Cancer imposes a considerable financial and emotional strain on both patients and healthcare systems

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due to its high mortality and morbidity rates. Add to that, there is an increase in cancer incidence due to population growth, increase in aging population, and an increase in risk factors.[4] This increase will eventually be a burden on the financial state of any healthcare system. The most typical primary brain tumor in adults is glioblastoma. The standard of care is for the complete surgical removal of the tumor, followed by radiation and chemotherapy.[5] A multidisciplinary approach, including neurologists, neurosurgeons, radiation oncologists, and neuropathologists, is the usual practice in treating patients with CNS tumors.[6] The financial burden of glioblastoma treatment on patients and healthcare systems is amplified by its aggressive nature and intensive therapeutic requirements . Including itemized costs, total costs of treatment regimens from diagnosis until death, the cost of second–line care after recurrence, and the incremental costs and cost–effectiveness of emerging therapies.[5]

Since –as mentioned above– there is an obvious increase in cancer incidence, a glance at Oman's health expenditure is needed to fully understand if Oman is capable of providing suitable care for such cases. The amount of money invested in healthcare covers services such as disease prevention, treatment, family planning, nutrition, and emergency health response. Still, it doesn't cover providing drinking water and sanitation. The amount of expenditure dedicated to health is usually related to the country's wealth, expenditures, and population. It's stated that increasing health expenditure is associated with better health outcomes.[7] However, the quality of health doesn't depend solely on outcomes but on structure and process also as The Donabedian model stated.[8]

A well–known example is the USA, in 2017, the United States spent 16.8% of its gross domestic product on healthcare, whereas the following highest comparable country (Switzerland) devoted 11.5% to this category.[9] It's important to mention that despite the huge amount of money spent, the US is still ranked as one of the worst in some healthcare parameters, such as the prevalence of chronic diseases and short life expectancy.[10] Oman can be considered as an opposite example to the U.S., the Omani Ministry of Health spent 6.4% of its gross domestic product on health in 2017.[11] Despite being a developing nation the Omani healthcare system was considered among the best according to World Health Organization reports which means that Oman managed to channel its limited resources to what suits its citizens.[12]

The goal of our study is to investigate the direct costs of brain tumors in the Neurosurgery Department at Khoula Hospital in Oman. The rationale for our study is to determine the cost of cancer treatment and understand its significant cost burden on patients and health system.

Methods and study design

This is a retrospective observational study. The study was approved by the ministry of health research ethics committee, approval number PRO0102019044. It was conducted at the Neurosurgery Department at Khoula Hospital in Oman. The study included 280 patients with brain tumors. It included patients who were diagnosed with brain tumors between Jan/2017 to Dec/2018.

The study included patients with brain tumors who received treatment at the Neurosurgery Department of Khoula Hospital in Oman (no age or gender restrictions).

The study excluded patients with incomplete medical records, those transferred for treatment elsewhere, extra–cranial tumors, those offered foreign treatment, or those seen in the clinic but refusing admission and treatment.

The study collected data on participants' demographics (age, gender, etc.), brain tumor type, diagnosis, treatment, imaging/lab costs, hospital stay length, and surgeries from their medical records.

The study analyzed medical records using Statistical Package for the Social Sciences (SPSS) software, calculating means and standard deviations for continuous data and frequencies and percentages for categorical data.

Results

The study included 280 participants. Out of those 150 were males and 130 were females. The mean age was 39 years Ranging from 2 to 90 years (SD+/– 20.9). Length of hospital stays varied from 1 to 155 days for each patient with an average of 16 days, a total number of days found to be 4642 (SD +/–20.6). Of 4642 days in the hospital, 1223 days were in the Intensive care unit (ICU) (SD +/–15), ranging from 0 to 180 days with an average of 6 days for each patient, and the rest were in the wards. Table 1 highlights the age distribution and admission details for patients.

Variable	Average	Median	Range	Standard Deviation	Total
Age	39.3	41	2–90	20.9	N/A
Length of Hospital Stay	16	12	1–155	20.6	4642
ICU Stay	6.3	2	0–108	14.8	1223

Table 1: Age distribution and length of hospital stay and ICU stay in days

In this study, the cost of imaging investigations done on the 280 patients was calculated in US dollars. The total cost of imaging of all patients was found to be 208168.7 USD, for a total number of 1402 requests.

The highest cost goes to Computer tomography (CT) scans, with 530 images requested, totaling 110,107.50 USD at 207.75 USD per request. This is followed by Magnetic resonance imaging scans (MRI), with 324 requests costing 84,139.56 USD, at 259.69 USD each. There were 449 X–ray requests costing 9,330.22 USD, at 20.78 USD each. Additionally, 36 Ultrasound Scan (USS) requests cost 1,869.84 USD, at 51.94 USD per request.

Eighteen Intraoperative neurophysiological monitoring (IONM) procedures were done, costing 934.92 USD, at 51.94 USD each. Ten venous Doppler procedures were performed, costing 649.20 USD. Sixteen Electroencephalogram (EEG) requests cost 415.52 USD, at 25.97 USD each. Five visual potential tests were performed, costing 259.70 USD, at 51.94 USD each. Two carotid Doppler tests were done, costing 129.84 USD, and four mammograms cost 124.64 USD.

There were five echocardiogram (ECHO) requests, costing 129.85 USD in total, and the least cost was for electrocardiogram (ECG), with 77.91 USD for three requests. Table 2 displays imaging investigations and their cost.

A total of 5,341 laboratory tests were conducted, costing 68,124.63 USD. The most expensive investigation was Renal Function Test (RFT), with 745 tests costing 9,677.55 USD, followed by 602 multi–drug–resistant (MDR) and 530 Methicillin–resistant Staphylococcus aureus (MRSA) screening requests costing 7,891.98 USD and 6,884.70 USD respectively, and 619 Complete blood count (CBC) requests costing 4,822.01 USD. Tables 3–7 provides details and prices of all laboratory tests.

	Total number	Single price	Total cost
CT	530	207.75	110107.5
MRI	324	259.69	84139.56
X–ray	449	20.78	9330.22
EEG	16	25.97	415.52
USS	36	51.94	1869.84
Mammogram	4	31.16	124.64
Carotid doppler	2	64.92	129.84
Visual potential	5	51.94	259.7
IONM	18	51.94	934.92
Echocardiography	5	25.97	129.85
Venous doppler	10	64.92	649.2
ECG	3	25.97	77.91
Total	1402	882.95	08168.7

Table 2: Cost of imaging investigations

The most common diagnosis was meningioma, with 52 cases, accounting for 18% of the total number of cases. Other types included 35 cases of pituitary adenoma, 32 cases of glioblastoma, 17 cases of astrocytoma, 13 cases of glioma, 12 cases of craniopharyngioma, 8 cases of schwannoma, 7 cases each of medulloblastoma, chordoma, lymphoma, ependymoma, oligoastrocytoma, oligodendroglioma, and glioblastoma multiforme. Additionally, there were 3 cases each of neurocytoma and dermoid cysts, 2 cases of papillary tumor and osteoma, and 1 case each of eosinophilic granuloma, cholesterol granuloma, dysembryoplastic neuroepithelial tumor, osteofibrous dysplasia, cystic cortical–based lesion, and Langerhans giant cell tumor. Besides the primary tumors, there were 27 cases of metastasis and 17 cases without a definite diagnosis. The various tumor types are shown in Table 8.

Discussion

Economic evaluation is important for guiding healthcare providers in making decisions about resource allocation. This study aims to study the direct costs of brain tumor management in the neurosurgery department at Khoula Hospital in Oman, given the higher incidence of brain and central nervous system tumors in the country, as reported by the Global Health Data Exchange.[13] Oman offers free public healthcare services and these studies are crucial in understanding cost burden for better future resource allocation.

First, the duration of both hospital and ICU stays played a significant role in driving up costs. ICU patients require more specialized care and resources, including highly trained staff, and they face a greater risk of complications, which often leads to longer stays. Our study saw an average of 16 days spent in the hospital, with nearly half spent in the ICU. In Oman, the average daily cost is $94 USD for a standard inpatient bed and $390 USD for an ICU bed.

Earlier studies have estimated that inpatient surgical care takes about 50% of hospital expenditures and 30% of overall healthcare costs.[15] Another study found that the daily cost of ICU care ranged from €1168 to €2025, with an average cost of €1597. However, we were unable to compare the ICU stay costs of our patients in Oman with other countries due to the lack of available data on ICU costs in Oman.

The test	Total number was requested	Price of the test	Total cost
Arterial blood gas	6	12.98	77.88
Urine microscopy	41	5.20	213.2
MRSA screening	530	12.99	6884.7
MDR screening	602	12.99	7819.98
Coagulation profile	169	6.49	1096.81
Blood group	128	7.79	997.12
Brucella	2	7.79	15.58
Save serum	169	12.99	2195.31
Random blood sugar	323	5.20	1679.6
Liver function tests	196	12.99	2546.04
Renal function tests	745	12.99	9677.55
Complete blood count	619	7.79	4822.01
C–reactive protein	126	12.99	1636.74
Thyroid function test	35	51.95	1818.25
Fasting blood sugar test	1	12.99	12.99
Alkaline phosphatase	2	5.20	10.4
TORCH	1	10.39	10.39
Beta–HCG	15	12.99	194.85
Alpha fetoprotein	17	12.99	220.83
Cortisol	52	18.18	945.36
Urine osmolality	17	5.20	88.4
Urine spot potassium	42	12.99	545.58
Urine spot sodium	57	12.99	740.43
Serum osmolality	12	5.20	62.4
Antibody screen	104	3.90	405.6
Sputum culture	2	11.69	23.38
Tuberculosis culture	3	11.69	35.07
Mycobacterium tuberculosis complex DNA	3	134.55	403.65
Quantiferon Tuberculosis gold test in blood	2	11.69	23.38
Erythrocyte sedimentation rate	27	5.20	140.
Urine culture	169	11.69	1975.61
Hepatitis C antibody	5	12.99	64.95
Hepatitis B surface antigen	12	12.99	155.88
HIV 1+ 2 Ag/Ab	12	12.99	155.88
Troponin T	17	8.31	141.27
Gentamicin trough level	3	16.88	50.64
Swab culture	17	11.69	198.73
Specific gravity of urine	41	11.69	479.29
Histopathology Examination	143	38.96	5571.28
Carcinoembryonic antigen	13	12.99	168.87
Magnesium in serum	45	5.20	234
Phosphorus	45	6.49	292.05
Calcium panel adjusted for albumin	44	5.20	228.8
Peripheral smear	11	5.20	57.2
Catheter tip culture	12	11.69	140.28
Body fluid microscopy	9	5.20	46.8
Fluid culture	12	10.39	124.68
Bone profile	8	12.99	103.92
Gram stain	49	12.99	636.51
Tracheal secretions culture	2	6.49	12.98
Endotracheal tube secretion culture	33	6.49	214.17
Sickle cell test	48	5.20	249.6
Anaerobic blood culture	17	12.99	220.83
Aerobic blood culture	12	12.99	155.88
Biopsy culture	21	11.69	245.49
Vancomycin–trough	9	25.98	233.82
Cerebrospinal fluid analysis	45	12.99	584.55
Cerebrospinal fluid culture	39	12.99	506.61
Cerebrospinal fluid microscopy	37	5.20	192.4
Frozen section	71	25.98	1844.58

Central venous catheter	2	11.69	23.38
Glycated hemoglobin	13	12.99	168.87
levetiracetams	1	12.99	12.99
Phenytoin	13	12.99	168.87
Aspartate aminotransferase	1	5.20	5.2
Follicle–stimulating hormone	20	15.59	311.8
Luteinizing hormone	20	12.99	259.8
Growth hormone	14	12.99	181.86
Prolactin	24	12.99	311.76
Brucella real time PCR	2	12.99	25.98
Body fluid cytology	23	25.98	597.54
Stool routine	2	12.99	25.98
Carbapenem–Resistant Enterobacteriaceae confirm	4	15.59	62.36
Blocks/ slides for review	7	77.93	545.51
Wound swab	7	5.20	36.4
Pediatric blood culture	8	12.99	103.92
Growth scan	7	64.94	454.58
Stool for Clostridium difficile	4	18.18	72.72
Lactate dehydrogenase	2	5.20	10.4
Lactate	1	12.99	12.99
Yeast identification	1	7.79	7.79
Rapid Plasma Regain Card Syphilis Test	1	12.99	12.99
Syphilis Screening test (ELISA) in serum	1	12.99	12.99
Pap smear	1	25.98	25.98
Anti–nuclear Factor	2	7.79	15.58
Anti–Neutrophil Cytoplasmic Ab	1	28.57	28.57
Isoelectric focusing oligoclonal bands	1	59.74	59.74
Cancer antigen 19.9	1	12.99	12.99
Cancer antigen (125)	1	12.99	12.99
Valproate	1	12.99	12.99
Blood transfusion	29	12.99	12.99
Glucose–6–phosphate dehydrogenase	2	12.99	25.98
Adrenocorticotropic hormone	3	49.35	148.05
Sputum microscopy acid fast stain	2	5.20	10.4
High–performance liquid chromatography	1	12.99	12.99
Transferrin	1	12.99	12.99
Low molecular weight heparin assay	1	15.59	15.59
Fungal culture	2	5.20	10.4
Lipid profile	3	12.99	38.97
Cardiac enzymes	2	25.98	51.96
Thyroid stimulating hormone	16	12.99	207.84
Echinococcus (Hydatid) screening	3	57.15	171.45
Direct bilirubin	1	5.20	5.20
Folate	1	12.99	12.99
Vitamin B12	2	12.99	25.98
Uric acid	1	5.20	5.20
Free T4	14	12.99	181.86
Anti–musk antibody	16	174.03	2784.48
Creatine Kinase	1	5.20	5.20
Acetylcholine receptor antibody	1	109.10	109.10
Insulin–like growth factor 1	1	14.29	14.29
Prostatic specific antigen (PSA)	1	12.99	12.99
Rheumatoid factor	1	7.79	7.79
Testosterone	1	12.99	12.99
Total	**5341**	**2028.88**	**68124.63**

Table 3: Cost of laboratory investigations

Tumor type	Number of patients with diagnosis
Meningioma	52
Astrocytoma	17
Schwannoma	8
Medulloblastoma	7
Papillary tumor	2
Neurocytoma	3
Chordoma	7
Lymphoma	7
Eosinophilic granuloma	1
Teratoid/Rhabdoid tumor	2
Cholesterol Granuloma	1
Craniopharyngioma	12
Glioma (not – specified)	13
Osteoma	2
Dysembryoplastic neuroepithelial tumor	1
Osteofibrous dysplasia	1
Ependymoma	7
Cystic cortical based lesion	1
Dermoid cysts	3
Glioblastoma	39
Pituitary adenoma	35
Oligoastrocytoma	7
Oligodendroglioma	7
Langerhans giant cell tumor	1
Metastasis	27
Not diagnosed	17

Table 4: Types of brain tumors

The daily cost of non–ICU care ranged from €311 to €711, with an average cost of €51.[20] A study from Sweden found that the neurosurgery department had one of the highest admission rates, with an average stay of approximately 8.8 days.[21] Notably, our study observed an average inpatient stay of 16 days—twice the duration reported in the Swedish study—indicating that prolonged hospital stays may also be a significant cost factor in brain tumor care in Oman.

Investigations were the biggest contributing factor to cost increment in our study with imaging amounting to $208,168.70 and lab tests amounting to $68,124.63. The highest cost was attributed to CT scans, totaling $110,107.50 for approximately 530 requests, followed by 324 MRI requests costing $84,139.56 in total. X–rays ranked third with a total cost of $9,330.22 for 449 requests. The least expensive investigation was ECG, with a total of 3 requests costing $77.91. For laboratory tests, a total of 5,341 tests were conducted, amounting to an overall cost of $68,124.63. The highest–cost lab tests were RFT at $9,677.55, MDR screening at $7,891.98, and MRSA screening at $6,884.70 USD.

Although exact cost was not mentioned a study showed that pre–operative imaging significantly increased the total cost.18 In contrast, a different study elucidated that 6.4% of the direct costs were attributed to diagnostic efforts, whereas the remaining expenses were allocated to therapeutic interventions.[21] Our study did not include the cost of therapeutic procedures due to lack of access to that data, hence we cannot make a direct comparison, however, it does suggest a potential overutilization of diagnostic procedures in Oman.

In our study the treatment considered for patients was either surgical, medical, or conservative management based on the case and prognosis. 76.5% (209 patients) represent those who underwent surgical treatment, while 23.4% (64 patients) represent patients who underwent medical treatment. Regarding surgical intervention, 178 had craniotomy and excision of the intracranial lesion while the rest of 31 patients required trans–sphenoidal excision. Out of the 64 patients who had medical treatment, 3 were for radiotherapy, 3 for palliative care, and the rest came only for follow–up.

While we are aware of the type and frequency of therapeutic modalities, the exact cost of these procedures was not included in our study. A previous study on traumatic brain injuries in Oman reported that craniotomies for 21 patients cost a total of $30,000 USD, averaging approximately $1,429 USD per patient.[24] Although burr hole surgeries were not performed for our neuro–oncology cases, the same study reported that 30 burr hole procedures cost a total of $25,325, averaging approximately $844 USD per surgery. It can be deduced that patients who underwent surgical intervention would have incurred higher medical costs. However, it is not possible to determine whether the costs for patients who underwent surgical interventions were higher or lower than those who did not. Further studies are needed in Oman and globally to compare costs incurred due to surgical and medical interventions. Additionally, it is important to note the lack of clear documentation on

the reasons why some patients did not undergo surgical interventions.

Comparatively, a study done in Sweden analyzed the direct and indirect expenses associated with brain tumor care. This study found that Astrocytomas III–IV followed by meningiomas have the highest incidence hence the highest costs among other subtypes.[21] In our sample, meningiomas have the highest incidence as they were attributed to 18% of total cases.

The study highlighted the indirect costs amounted to a substantial sum of 11.6 million USD, primarily stemming from mortality occurrences within the population below 65 years of age. Notably, sick leaves and early retirement constituted significant contributing factors to these indirect costs. On the other hand, the direct costs totaled 51.7 million USD, encompassing expenditures associated with short–term, long–term, and ambulatory care. Notably, the majority (71%) of the direct costs were allocated to short–term hospital care. Furthermore, the study elucidated that 93.6% of the direct costs were attributed to therapeutic interventions. Among the therapeutic costs, a notable 79.9% pertained to surgical wards, while radiology therapy and cytostatic treatments accounted for 19.2% and 0.9%, respectively.[21] This indicates that more resources were allocated to therapeutic procedures.

A study published in 2020 demonstrated that pre–TBI – Traumatic Brain Injury – health status has an impact on the increase in direct medical cost by nearly 50% of such conditions as co–morbidities, mental health disorders, and other emergencies.17 Another recent study from the US demonstrated a 7% rise in the average cost of cranial neurosurgery cases for 3 years (2006–2009). This high cost can hurt overall health conditions, leading to medical access limitations, such as difficulty filling prescriptions, skipping recommended tests and investigations, and specialist consultation and care.[14]

On the other hand, a study done in the US showed a 6.2% decline in Medicare payments for inpatient surgical care over a period of 6 years. This was explained by a 3.7% annual increase in outpatient surgeries. Hospitalization, physician services, and post–acute care were the largest areas of spending.[15]

Studies have also shown a decline in payments for inpatient surgery, while witnessing a substantial surge in payments for outpatient surgical care, amounting to an increase of 8.5 billion USD. The escalation in costs was particularly prominent in specific medical fields, namely vascular oncology (105.5%), neurosurgery (97.8%), hand surgery (92.7%), interventional radiology (88.5%), and surgical oncology (88.4%). It is important to highlight that although these increases occurred in various specialties, orthopedic and general surgery remained at the forefront, accounting for the highest expenditures, with respective proportions of 17.8% and 11.2% in the year 2014.[15]

A study at Mulago National Referral Hospital (Kampala, Uganda) estimated the direct and indirect costs of neurosurgical procedures. An analysis of 1,440 medical records revealed that the average neurosurgical procedure cost $542.14, with a standard deviation of $253.62. Costs varied depending on the procedure, ranging from $291 for burr hole evacuations to $1,221 for brain tumor removal. For most surgeries, overhead costs represented the largest proportion of the total cost (29% to 41%).[19]

It was also seen that 28 patients from our study have signed LAMA. Dissatisfaction with the treatment, the urge to seek a second opinion and other financial, educational, and social reasons were a few of the common underlying causes for patients to seek LAMA. It was found that 2 out of the 28 patients in our study have signed LAMA with the motive of completing the treatment abroad. According to one of the few studies conducted regarding Omanis traveling abroad for healthcare, it has stated that such decisions were made after long delays in public healthcare facilities and few competitive and costly private facilities. Moreover, the results of a small survey conducted at A'dakhiliyah governorate in Oman in 2010 regarding the same matter, illustrated that 85% of patients weren't satisfied with the treatment, 6% wanted to confirm the treatment and 9% had an unidentified diagnosis.[16]

Postoperative complications represent a significant cost burden on healthcare systems. Notably, within the context of neurosurgical cases, the incidence of postoperative complications is reported to be 14.3%. A prior study highlighted the three most prevalent complications in their patient cohort, comprising unplanned 30–day readmissions (9.78%), venous thromboembolism (2.99%), and surgical site infections (2.17%). Moreover, the same study underscored the three most economically burdensome complications, namely surgical site infection, myocardial infarction, and sepsis, respectively.[22]

In this context, there is a study about the costs and outcomes of surgical site infection after coronary artery bypass grafting surgeries in Oman which revealed that the incidence rate of surgical site infection after Coronary artery bypass grafting (CABG) in Oman is high compared to other developing countries. Although the case fatality rate stood at 5.8%, it is crucial to acknowledge that the causes of death might not necessarily be solely attributed to surgical site infections. Of considerable significance, infected patients exhibited a strikingly higher 30–day readmission rate of 44.2% in contrast to the 2.2% rate observed in uninfected patients, inevitably imposing

substantial financial implications on the overall care costs for these patients.[23]

Limitations

The main limitations of this study are that it was conducted at a single center and that it did not include the costs of surgical and non–surgical interventions. Additionally, the study did not account for the potential long–term costs of brain tumor management, such as the cost of readmissions or the cost of treating complications.

Despite these limitations, this study provides valuable insights into the direct costs of brain tumor management in Oman. The study's findings suggest that the cost of brain tumor management is significant and that further research is needed to understand the full economic burden of brain tumor management. The study's findings also have important implications for healthcare policy and practice in Oman.

Conclusion

This paper conducted in Oman's Khoula Hospital explored brain tumor management costs. Analyzing 280 patients, revealed high costs for imaging (~$208,000) and lab tests (~$68,000). Meningiomas were the most diagnosed brain tumors. This raises the concern that brain tumors are expensive to manage in Oman, a nation with limited healthcare resources and rising brain tumor cases. The average 16–day hospital stay is double that of a similar Swedish study, potentially contributing to higher costs. Further research is needed to understand the full economic impact, including surgeries, non–surgical treatments, and long–term complications. Additionally, exploring reasons for longer stays and developing cost–effective treatments are crucial.

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