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Tafaul-Al-Ahsa Cancer Foundation Wins EXCELLENCE AWARD for Cancer Awareness Initiatives at Gulf Cancer Awareness Week 2024





The Gulf Oncology Society meeting resulted in fruitful outcomes, with young doctors showing keen enthusiasm for assuming leadership roles and implementing impactful initiatives.

The Official Journal of the Gulf Federation For Cancer Control

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Original Article

# Cost of Healthcare Services in Geriatric Neuro–oncology: A descriptive Analysis

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## Abstract

**Background:** The percentage of brain tumor incidence exceeds 50% in the geriatric population admitted at Khoula Hospital (a tertiary care hospital in Oman) as compared to the younger population, furthermore, geriatric patients impose a higher cost of healthcare in general. Therefore, geriatric tumor care is causing a significant burden on the healthcare service in Oman. For this reason, we have developed this study to identify the cost of care for this group.

**Methods:** Medical data with their costs were collected retrospectively for 108 patients diagnosed with a brain tumor above the age of 65 years and admitted at Khoula Hospital between 2016 and 2019.

**Results:** The two most common diagnoses in terms of incidence were Meningiomas (31.73%) and Glioblastomas (16.34%). Lymphoma peaked with regards to the cost, with an average cost of 8993.83 USD per diagnosis, followed by glioblastoma and then metastatic lesions (with 5039.18 and 4915.76 USD respectively). Of these surgeries, 82.61% were elective, most of which had a cost above or equal to the average. Emergency surgeries showed equal numbers above and below the average cost of surgeries ($P< 0.05$).

The total costs of imaging were 73759.4 USD, with CT (35.8%) + MRI (32.9%) forming 68.7% of the total imaging costs. While laboratory investigation costs totaled 64110.93 USD.

**Conclusion:** The cost of tumor care in Oman is variable based on multiple factors. The reported results represent useful information forming the basis for further analysis such as cost–benefit analysis, cost–effectiveness analysis, and cost–utility analysis.

**Keywords:** geriatric, oncology, cost study, brain tumors

## Introduction:

Geriatric tumor is defined as a cancer that affects older age of patients around 65 years and older [(1)]. The incidence of developing cancer in the elderly increased by 11–fold as compared to younger individuals[(2)]. The median ages for cancer diagnosis and death are 66 and 72 years respectively as reported by the National Cancer Institute's Surveillance Epidemiology and End Program [(3)]. The percentage of all newly diagnosed malignancies is 54% [(3)]. In addition, 70% of all cancer deaths occur in patients who are 65 years or older [(3)].

In 2016, there were 2015 tumors recorded in Oman. Among these, 88.3% occurred in Omani nationals out of a total of 1780 Omanis in which males accounted for 46.4% and females accounted for 53.6% [(4)]. According to a retrospective study of geriatric cases admitted to the Neurosurgical Department in Khoula Hospital (KH) the brain tumor incidence for ages 75–79 years was 7%, for

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ages 80–84 years was 20.4%, and for age 85 was 23.4% [5]. The proportion of the population who will be 65 years or above in Oman is expected to increase from 98,000 in 2015 to 888,000 in 2050 [6]. Over 60% of Canadians who are 65 years old or above diagnosed with cancer and more than 70% of them died [7]. In Oman, the number of deaths by cancer in 2020 was 2029 [8].

According to the previous statistic that was done in the USA in 2004, the net costs of care to Medicare for elderly cancer patients within 5 years were approximately $21.1 billion [9]. Care of old cancer patients is likely to be costly because it requires complex protocols and restricted therapy [1]. All physiological changes in the elderly including decreased hepatic blood flow which happens due to aging will result in decreased clearance and increased toxicity of drugs, which might negatively impact cancer treatment and cause doctors to develop more aggressive and often costly treatments [1].

Many factors can play an important role in the cost of cancer care such as tumor site, phase of care, stage at diagnosis, and survival [9]. Cancers such as prostate in male patients, and breast cancer in female patients are considered as most costly cancer care followed by lung cancer, and colorectal cancers among both genders [1]. The cost generally becomes higher at the initial stage of diagnosis and the last year of life [10].

The objective of this study was to identify the cost of healthcare services in geriatric neuro–oncology in Oman. This study was conducted because of a lack of local papers discussing the cost of cancer among elderly patients.

## Methods and Study Design

### Study Group

This retrospective research was carried out at Khoula Hospital (KH) in Muscat, Sultanate of Oman. The Research Ethical Committee of Khoula Hospital/Ministry of Health approved the project (7 December 2020; ID: PRO122020072). From January 01, 2016, to 31st of December 2019, medical data of 108 patients over the age of 65 who were hospitalized in the neurosurgical ward and diagnosed with a brain tumor or brain malignancy were included. Non–elderly patients (under 65 years), patients diagnosed with a tumor before the age of 65, hospitalized in the neurosurgical department for reasons apart from tumor or malignancy, and patients admitted outside the duration of the study (January 1, 2016, to December 31, 2019), and patients with incomplete or missing data are all excluded.

### Data Collection

Patient demographics (age, gender), presenting symptoms, pre–operative medical conditions, pre/post–operative complications (reoperation infection, surgical site infection, electrolytes imbalance, deep vein thrombosis (DVT)), previous surgical history, preoperative and postoperative Glasgow coma scale (GCS), tumor site, type of tumor, number of radiological scans (magnetic resonance imaging (MRI), computed tomography (CT), X–rays), indication for surgery, diagnosis, List of medications, and all performed investigations (complete blood count (CBC), coagulation profile, lipid profile, different tumor markers) were all obtained from the health information system (Al–Shifa Electronic Health Record System). Data on treatment options, such as surgery or conservative care, was gathered. The data was then divided into continuous and categorical variables, and the data were evaluated consequently.

### Data Analysis

The statistical package for the social sciences (SPSS) software (version 27) is used to evaluate and process the study database. Frequency tables and pie charts or bar charts were used to cross–tabulate the categorized variables. The Chi–square test was performed to determine the significance of the correlation between categorized variables, with a significant cut–off of p–value $\leq 0.05$. The categorical variables were defined by their counts and relative frequencies, while the numerical variables were summarized by their medians, means, and ranges.

## Results

Table 1 shows the demographic characteristics of the included cases in the present study. We have a total of 108 patients admitted to the neurosurgical department at KH in Muscat—the capital city of the Sultanate of Oman—in four years (from 2016 to 2019). The range of age was from 65 to 89 with a mean of 71.12. The male–to–female ratio was (1.1:1). Meningiomas were the most commonly found type of tumor (31.73 %) followed by Glioblastoma (16.34%). Most of the patients had a GCS score of 13–15 on admission. Most of the surgeries, 82.61% were elective surgeries, while 17.4% of surgeries were emergency surgeries. The length of stay range was from 1 to 144 days with a mean of 16.22. The length of stay in the ICU range was from 1 to 57 days with a mean of 7.679.

Table 2 shows the total number of radiological investigations and their cost in each year and total. The total number of radiological Investigations is 480 and the total cost is 73759.4 US dollars. Out of 480 different radiological investigations, 172 (35.8%) are CT and their total cost is 35776. While 129 (26.9%) are MRI which cost

| | |
|---|---|
| **Number of patients admitted** | |
| 2016 | 25 |
| 2017 | 27 |
| 2018 | 26 |
| 2019 | 30 |
| **Age (years)** | |
| Mean | 71.12 |
| Median | 70.50 |
| Range | From 65 to 89 |
| **Gender** | |
| Male: | 56 |
| Female: | 52 |
| **GCS** | |
| 3–8: | 12 |
| 9–12: | 15 |
| 13–15: | 74 |
| **LOS (days)** | |
| Range | From 1 to 144 |
| Mean | 16.22 |
| Median | 10.000 |
| **LOS (ICU) (days)** | |
| Range | From 1 to 57 |
| Median | 3.0 |
| Mean | 7.679 |
| **Diagnosis** | |
| Meningioma | 33 |
| Glioblastoma | 17 |
| Benign neoplasm (not specified) | 8 |
| Malignant neoplasm (not specified) | 8 |
| Pituitary adenoma | 7 |
| Metastatic lesions | 4 |
| Unknown neoplasm | 5 |
| Lesions with hydrocephalus | 3 |
| Lymphoma | 3 |
| Intracranial cyst lesion | 3 |
| glomus tympanicum | 2 |
| hemangioma | 1 |
| Neurofibromatosis | 1 |
| Unspecified lesion | 9 |
| **Type of surgery** | |
| Elective | 57 |
| Emergency | 12 |

**Table 1.** Demographic information (n = 108 patients).

| Radiological modality | Number | Cost (USD) |
|---|---|---|
| CT | 172 | 35776 |
| 2016 | 31 | 6448 |
| 2017 | 59 | 12272 |
| 2018 | 37 | 7696 |
| 2019 | 45 | 9360 |
| MRI | 129 | 33540 |
| 2016 | 24 | 6240 |
| 2017 | 44 | 11440 |
| 2018 | 33 | 8580 |
| 2019 | 28 | 7280 |
| X–ray | 158 | 3286.4 |
| 2016 | 46 | 956.8 |
| 2017 | 41 | 852.8 |
| 2018 | 35 | 728 |
| 2019 | 36 | 748.8 |
| Echocardiogram | 7 | 182 |
| 2016 | 0 | 0 |
| 2017 | 1 | 26 |
| 2018 | 2 | 52 |
| 2019 | 4 | 104 |
| Ultrasound scan | 9 | 585 |
| 2016 | 4 | 260 |
| 2017 | 0 | 0 |
| 2018 | 2 | 130 |
| 2019 | 3 | 195 |
| Venous Doppler scan | 5 | 325 |
| 2016 | 0 | 0 |
| 2017 | 1 | 65 |
| 2018 | 0 | 0 |
| 2019 | 4 | 260 |
| Venogram of Limbs | 1 | 65 |
| 2016 | 0 | 0 |
| 2017 | 0 | 0 |
| 2018 | 0 | 0 |
| 2019 | 1 | 65 |
| Total | 480 | 73759.4 |

**Table 2.** Radiological Investigations cost in USD.

33540. 158 (32.9%) are X–rays with a cost of 3286.4. 7 (1.46%) are echocardiograms and their total cost is 182. Ultrasound scan total number out of 480 is 9 (1.9%) and their cost is 585. Venous Doppler scan total number out of 480 is 5 (1.04%) and their cost is 325. The venogram of Limbs scan total number out of 480 is 1 (0.21%) and their cost is 65.

Different complications are listed in table 3. The top commonly found complications were in the order, persistent headache, seizure, dizziness, and walking imbalance.

Table 4 displays the total number of tests done and their cost per year as well as their average per patient. It shows that 2677 tests were done throughout the 4 years span of the study with a cost of 64147.33$. resulting in an average of 6.497573 with an average cost of 155.6974$.

Table 5 shows the average cost per year. The total cost was 16687.17052. The descending order of years from higher cost to least is 2019 ,2017 ,2018 ,2016.). The cost of most elective surgical cases was above or equal to the average cost, while there were an equal number of cases – below and above or equal to the average cost – in emergency surgery ($p = 0.000047$). The average cost of prolonged LOS was above or equal to the average. In non–prolonged cases, 50.96% of the cases were above or equal to the average cost and 49.03% were below the average cost ($p = 0.053874$). In meningioma, 54.286% of the cases were above or equal to the average cost. While in non–meningioma cases 52.1% were above or equal to the average cost ($p = 0.827932$). In addition, 84.62% of glioma cases were above or equal to the average cost. In non–glioma, 48.94% of the cases were above or equal to the average cost ($p = 0.038249$).

Figure 1 illustrates the average cost and diagnosis. Lymphoma took the higher cost followed by glioblastoma then metastatic lesions. Other diagnoses and their cost are shown in the figure.

| | |
|---|---|
| Persistent Headache | 12 |
| Seizure | 8 |
| Dizziness | 8 |
| Walking imbalance | 6 |
| Weakness | 4 |
| DVT | 4 |
| Change in behavior | 4 |
| Cardiac arrest and death | 3 |
| Palpitation | 3 |
| UTI | 3 |
| Change in vision: | 3 |
| LOC | 3 |
| Confusion | 3 |
| Unspecified Infection | 3 |
| Chest infection | 2 |
| Sepsis | 2 |
| Mode change | 1 |
| Surgical site hematoma | 2 |
| Bed sore | 1 |
| Cellulitis | 1 |
| Fungal infection: | 1 |
| 7th cranial nerve palsy | 1 |
| Urine incontinence | 1 |
| Tinnitus | 1 |
| Ptosis | 1 |
| Proptosis | 1 |

**Table 3.** Compilations.

Abbreviations: DVT= deep vein thrombosis, UTI= urinary tract infection, LOC= loss of consciousness.

| Year | Average of test Number per patient | Total number of tests | Average of Cost (USD) | Total Cost (USD) |
|---|---|---|---|---|
| 2016 | 8.407767 | 866 | 159.4406 | 16422.38 |
| 2017 | 4.533981 | 467 | 163.5615 | 16846.83 |
| 2018 | 5.699029 | 587 | 147.449 | 15187.25 |
| 2019 | 7.349515 | 757 | 152.3385 | 15690.87 |
| Grand Total | 6.497573 | 2677 | 155.6974 | 64147.33 |

**Table 4.** Total and average number of laboratory tests with total and average 'Cost (USD)' per year

| Year | Average Cost/Year (USD) |
|---|---|
| 2016 | 3373.4968 |
| 2017 | 4594.007407 |
| 2018 | 3892.792308 |
| 2019 | 4826.874 |
| Total | 16687.17052 |

**Table 5.** Average Cost/Year in USD

## Discussion

Our retrospective study focused on the costs of interventions and treatment for geriatric tumors in a tertiary care hospital over a one–year period. The hospital involved in the research is in the capital city – Muscat, Sultanate of Oman.

Based on our knowledge, this is the first study to estimate the cost of geriatric tumor–related investigation and treatment in the country. The limited number of studies retrieved in our study indicates the lack of research on this topic [11]. The cost has varied based on the diagnosis as well as LOS and the outcome. The average total cost over the 4 years in the neurosurgery department for the 108 patients analyzed has been USD 16687.17052 which is relatively smaller compared to the other tumor–related costs in the country. In Oman, healthcare costs are covered by the government, however, the out–of–pocket costs for medications in the elderly were significant, with spending on supportive care medications being almost double of the expenses on cancer–directed medications in the US [12].

The highest cost of treatment when analyzed annually shows that 2019 has seen maximum expenditure when it comes to the cost of treatment. Economic analyses of elderly cancer care tend to overlook nonmedical costs, challenging comprehensive cost capture due to evolving treatments, highlighting the need for strategies like drug price negotiation and personalized therapies to counter rising costs while emphasizing the importance of recognizing clinical and economic impacts across all age groups [13].

In a span of 4 years (2016–2019), 108 patients were admitted to the Neurosurgery Department in Khoula Hospital with 2019 seeing the maximum surgeries and least surgeries in 2016.

Meningiomas are the most diagnosed tumor, followed by Glioblastomas as per our data. In 2011, the adult survivors of hematologic cancer in the United States spent $24.9 billion for treatment, the third highest expenditure among high–incidence cancers [14]. These patients may require stem cell or bone marrow transplants which disproportionately increases the costs. Only 17.5% of the total surgeries were emergencies whereas 82.61% of the surgeries were elective with a length of stay of 144 with a mean of 3.804, and a length of stay in the ICU range of 52 with a mean of 3.804.

In a span of 4 years, a total of 480 radiological investigations were carried out with a total cost of 73759.4 USD. 35.8% of these investigations were CT scans and their total cost is 35776. 26.9% of these are MRIs with their total cost being 33540, 32.9% are X–rays with a cost

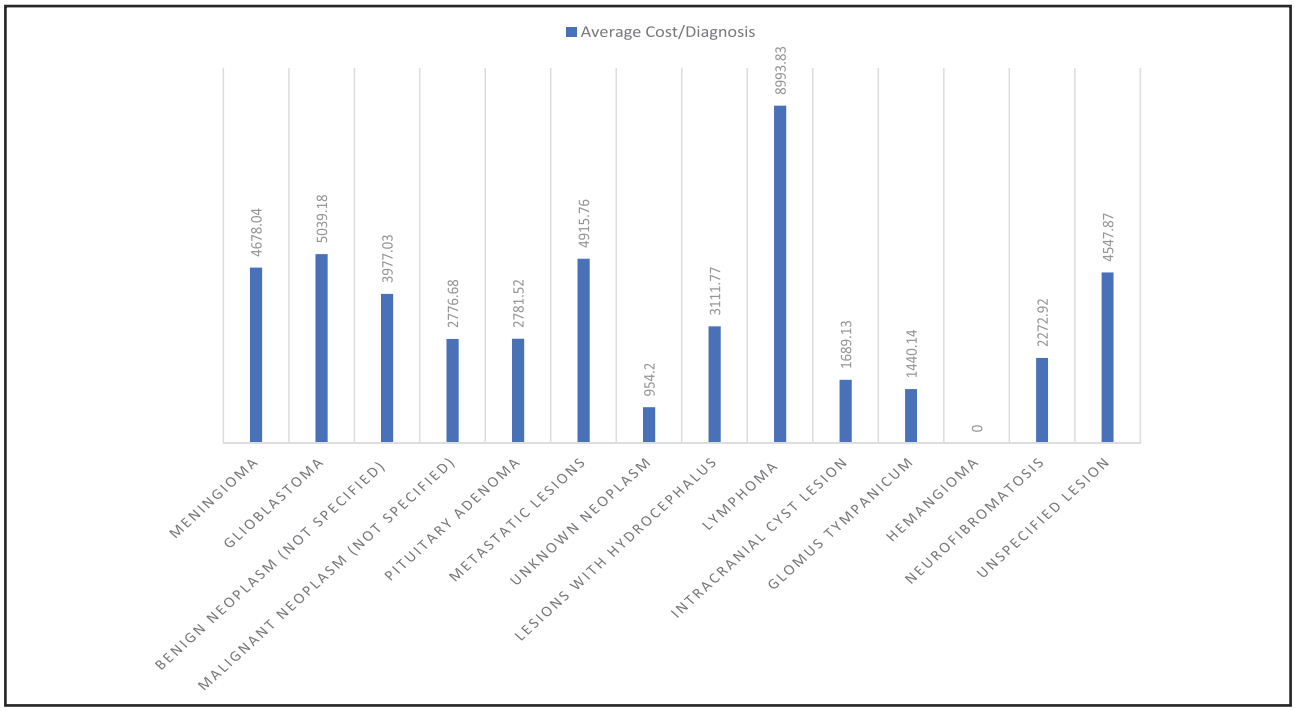



**Figure 1.** Average Cost/Diagnosis in USD

of 3286.4, 1.46% are echocardiograms and their cost has been 182. The remainder of the radiological investigations include venous doppler at 1.04% and venogram of limbs at 0.21% with the total cost being at 390.

Despite MRI scans being the most expensive investigation, the number of scans run in the 4 years has been comparatively less compared to CT scans being the most used radiological investigation and having the highest collective cost.

The findings in Table 4 provide critical insights into the financial and utilization implications of neuro–oncology testing over the research period. With a total of 2677 tests performed over four years, the data reveals the substantial volume of diagnostic procedures undertaken in this specialized field. Furthermore, the cost analysis highlights that these tests incurred a total expenditure of $64,147.33, translating to an average cost of $155.6974 per test. Importantly, when considering the average per neuro–oncology patient, the figures indicate an average of 6.497573 tests conducted per patient, underscoring the comprehensive nature of diagnostic evaluation within this patient population. These findings shed light on the frequency and financial burden of neuro–oncology testing, providing valuable benchmarks for healthcare providers and policymakers in resource allocation and cost–effectiveness assessments. Further research and discussion on optimizing testing protocols and resource utilization in neuro–oncology settings are warranted to ensure equitable and efficient patient care.

This paper also focused on the complications with headaches being the most common complication of all.

This study, however, did not elaborate on the costs of the treatment or how the different treatment plans may have affected the costs. However, hospitalization has been the single largest component of cost for most neurological tumors in the geriatric age groups. Clinic visits, outpatient clinics, and follow–up have not been analyzed either. Despite not being specifically designed for cost assessment, evidence indicates Comprehensive Geriatric Assessment (CGA) benefits older cancer patients, including reduced LOS and decreased Adverse Drug Events (ADEs), indicating potential cost–effectiveness [11]. CGA's integration in oncology care involves longer encounters, impacting clinics economically [15]. In Canada, geriatric assessment saved CAD 7387 per patient which shows that it is sensitive and should be implemented more widely [12].

The cost estimates for geriatric neurological tumors may understate the costs for younger cancer patients who may undergo more aggressive and more advanced treatment. The highest–cost inpatient visits for elderly cancer patients were five times more expensive than others, driven by factors like increased comorbidities, hematologic malignancies, chemotherapy, metastatic cancer, and major procedures, underscoring the need to identify these drivers for implementing effective cost–containment strategies [16]. In the US, elderly NET patients, those with the pancreas as the primary cancer site exhibited the most elevated costs [17]. National estimates about the cost of care for tumors are not available yet and further study in the matter is pending.

## Limitations

This descriptive analysis of healthcare services in geriatric neuro–oncology is subject to several notable limitations. Firstly, it is imperative to acknowledge that this study is retrospective and conducted at a single center, spanning a four–year period. Consequently, the findings may not fully encapsulate the evolving landscape of medical technology and the availability of advanced diagnostic facilities, which can influence patient care and costs. Furthermore, an important aspect omitted from this analysis is the expenditure associated with medications, a factor that could significantly augment the overall financial burden on patients and the healthcare system (Supplement). Additionally, the absence of data regarding patient follow–up represents a limitation, as it hinders our ability to assess the long–term implications of the care provided. Lastly, this study does not delve into the specific oncological causes of spinal–related disorders, with the intention of addressing these matters in a forthcoming paper alongside a comprehensive exploration of all other neurosurgical tumors. These limitations underscore the need for further research and a more comprehensive examination of the multifaceted aspects of geriatric neuro–oncology care.

## Conclusion

In conclusion, this retrospective study on the costs of interventions for geriatric tumors in a tertiary care hospital over a four–year period reveals significant variations in costs based on diagnosis, length of stay, and outcomes. Notably, there are no previous studies in this context. The annual cost per diagnosis varies, with lymphoma incurring the highest average cost, followed by glioblastoma and metastatic lesions. To further our understanding and inform healthcare decision–making, future directions should include conducting in–depth analyses, such as cost–benefit analysis, cost–effectiveness analysis, and cost–utility analysis, which can offer more comprehensive insights into the value and efficiency of interventions for geriatric tumors.

## Conflicts of interest:

No

## Abbreviations:

DVT= deep vein thrombosis, UTI= urinary tract infection, LOC= loss of consciousness, KH: Khoula Hospital, GCS: Glasgow coma scale, MRI: Magnetic resonance imaging, CT: Computed tomography, CBC: Complete blood count, MRSA: methicillin–resistant Staphylococcus aureus, LOS: Length of stay

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