Market Analysis and Patient Sub-segment Identification for Glioblastoma Multiforme (GBM) Entry Strategy

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This report offers a comprehensive analysis of the Glioblastoma Multiforme (GBM) therapeutic area to facilitate our client's decision-making process as they contemplate entering this specialized field. Our primary focus is on understanding the structure of the GBM market, specifically identifying clinically significant patient subgroups that receive distinct treatments. The ultimate objective is to unveil distinct opportunities within this challenging and critical medical landscape.

GBM Overview

Glioblastoma Multiforme (GBM) stands as the most common and aggressive primary malignant brain tumor in adults. It originates from glial cells in the brain, particularly astrocytes. GBM is characterized by its highly invasive nature, rapid growth rate, and a high recurrence rate, making it a formidable challenge to treat. The standard treatment protocol includes surgery, radiation, and chemotherapy, with Temozolomide being a common chemotherapy drug. Despite aggressive treatment, prognosis remains bleak.

Descriptive Statistics To better understand the GBM market, we will do some analysis utilizing GBM data of 750 patients from 150 healthcare providers.

	mean	sd	min	median	max	range
year_of_birth	1957.898667	12.031906	1925	1957.0	1996	71
age_at_diagnosis	56.897333	12.230709	19	57.0	88	69
pct_of_tumor_mass_surgically_resected	70.098901	24.275281	10	77.5	100	90
comorbidity_count	1.126667	1.293388	0	1.0	8	8

variable	categories	count	percent
line_of_therapy	1L	300	40%
line_of_therapy	2L	450	60%
gender	Female	259	35%
gender	Male	491	65%
race	Asian	30	4.0%
race	Black	110	14.7%
race	Hispanic	44	5.9%
race	Other	3	0.4%
race	White	563	75.1%
patient_level_of_involvement	Low	76	10%
patient_level_of_involvement	Average	382	51%
patient_level_of_involvement	High	292	39%
patient_treatment_goals	Survival	515	69%

variable	categories	count	percent
patient_treatment_goals	Life Quality	235	31%

In this dataset, the age at GBM diagnosis varies, with the median and mean closely aligned, suggesting a **symmetric distribution**. GBM primarily affects **adults**, with no diagnoses on or before age 18. Surgical resection has a mean percentage of 70.1% and a slightly higher median indicating a **left-skewed distribution**. Average comorbidity count is around 1, highlighting **minimal comorbidities**.

The majority of participants are **White** (75.1%) and **male** (65%). A more diverse study is needed for a comprehensive view of GBM across races. Most patients undergo **second-line therapy** with a balanced distribution between therapy lines. Around half have **average GBM involvement**, the remainder has a larger proportion showing high involvement compared to low involvement. Most patients prioritize **survival** (69%) over life quality (31%). No categorical variable displayed significant disparity in the chi-square test (significance level: 0.05).

Comorbidities There are a number of comorbidities that can co-occur with GBM. There is a maximum of 8 comorbidities co-occurring with GBM in record. **Hypertension** is the most prevalent comorbidity (24% of sample), followed by **diabetes** (18.4% of sample), **anemia** (15.6%), **chronic obstructive pulmonary disease** (11.5%), and **renal impairment** (10.5%), many of which share similar risk factors and medication overlap.

Genetic Factors

	mgmt_methylated	egfr_mutated	tp53_mutated	idh1_idh2_mutated	pd_l1_overexpressed
No	37.20000	26.80000	24.40000	23.06667	21.60000
Yes	28.26667	21.73333	16.66667	12.13333	14.13333
Unknown	34.53333	51.46667	58.93333	64.80000	64.26667

Table above shows genetic factor variables and their percentages. There are a number of genetic factors associated with GBM. In this dataset, genetic factors include:

- **MGMT methylated:** The MGMT gene's methylation status. When methylated, the MGMT gene is less active, which can affect how GBM responds to certain treatments.
- **EGFR mutated:** Indicates mutations in the EGFR gene, which plays a role in cell growth. Mutations can lead to uncontrolled cell growth, a characteristic of many tumors.
- **TP53 mutated:** Mutations in the TP53 gene are present. This gene helps regulate cell growth and repair damaged DNA. Mutations can promote tumor development.
- **IDH1/IDH2 mutated:** Mutations in the IDH1 or IDH2 genes are linked to cancer growth. These mutations can influence treatment choices and outcomes for GBM patients.
- **PD-L1 overexpressed:** The PD-L1 protein is overproduced, potentially suppressing the body's immune response to the tumor. This can inform decisions about immunotherapy treatments.

Lines of Therapy Chi-squared test did not identify significant difference between the proportions of patients taking 1st line and 2nd line of therapy. For the distinct difference between 1st and 2nd line of therapies in nature, we will next explore some visualizations sub-grouped by line of therapy.

- **1st Line of Therapy:** Regimen used in 1st line of therapy include Avastin + Irinotecan, Avastin + Lomustine, Avastin + TMZ, Avastin mono, Gliadel wafers, Lomustine mono, Other, TMZ mono. The most popular regimen used is TMZ mono, which accounts for 48.40% of all regimens recorded. The least popular regimen used is Other, specifically , Irinotecan, lomustine, which altogether accounts for 0.27% of all regimens recorded.

- **2nd Line of Therapy:** Regimen used in 2nd line of therapy include Avastin + Irinotecan, Avastin + Lomustine, Avastin + TMZ, Avastin mono, Gliadel wafers, Lomustine mono, Other, TMZ mono, Unknown. Excluding Unknown, the most popular regimen used is Avastin mono, which accounts for 28.89% of all regimens recorded. The least popular regimen used is Gliadel wafers, which accounts for 0.44% of all regimens recorded.

ECOG The Eastern Cooperative Oncology Group (ECOG) Performance Status is a widely-accepted scale utilized to evaluate the functional capacity of cancer patients. This assessment tool offers insights into a patient's ability to endure treatment and their overall prognosis. A lower score denotes a better functional status, whereas a higher score suggests more significant functional impairment.

	ecog_at_1st_line	ecog_at_2nd_line
ECOG 0	22.000000	9.6000000
ECOG 1	50.266667	20.6666667
ECOG 2	15.733333	22.6666667
ECOG 3	1.733333	6.4000000
ECOG 4	10.266667	0.6666667
Unknown	22.000000	40.0000000

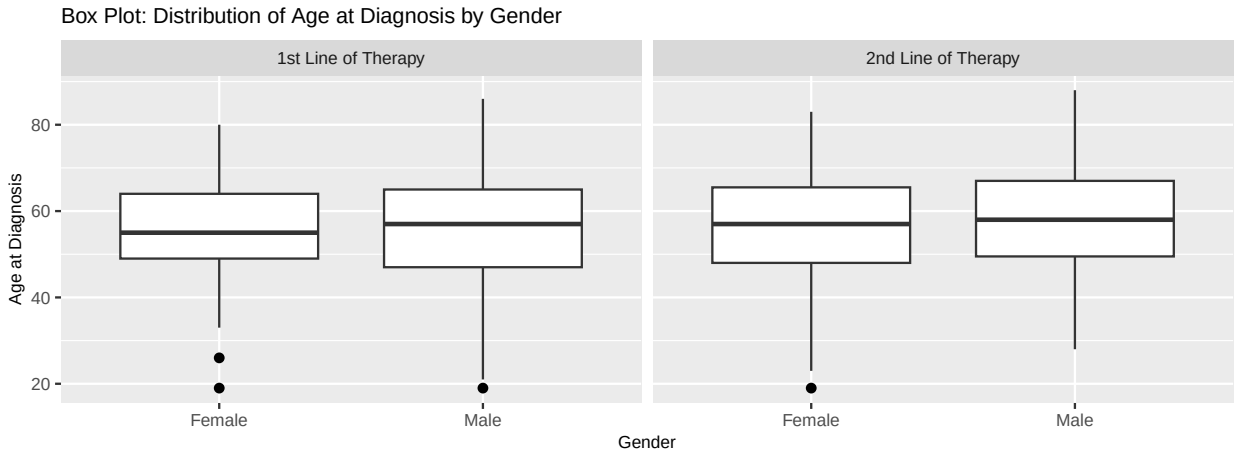
- ECOG 0: Fully active, able to carry on all activities without restriction. This subsegment of patients is generally in the best health amongst those with cancer and is likely to tolerate aggressive treatments well.
- ECOG 1: Restricted in physically strenuous activity but able to walk and carry out light work. These individuals might require some adjustments to their treatment regimens but are largely capable of leading an active life.
- ECOG 2: Ambulatory and capable of self-care, but unable to work; out of bed more than 50% of waking hours. The health of this segment is moderately compromised, warranting careful consideration of treatment intensity to prevent further functional decline.
- ECOG 3: Capable of only limited self-care, confined to bed or chair more than 50% of waking hours. Such patients are significantly impaired and might benefit from supportive care interventions to enhance their quality of life.
- ECOG 4: Completely disabled, cannot carry out any self-care, confined to bed or chair all the time. This is the most critically impaired group. Palliative care and symptom management might be of prime importance to these patients.

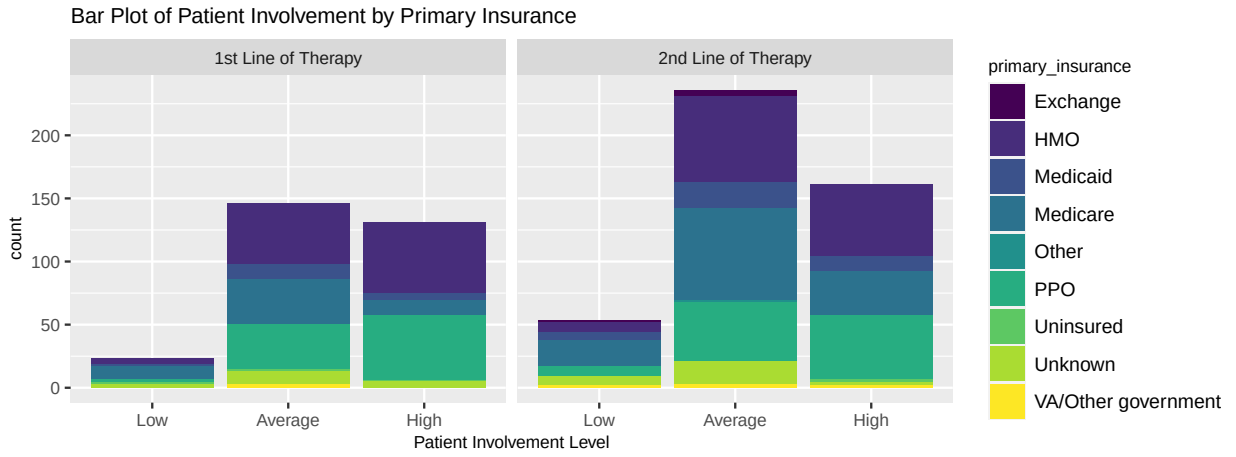
For those on 1st line of treatment, ECOG 1 accounts for an overwhelming proportion, followed by ECOG 0, ECOG 2, and ECOG 4. This distribution suggests a mix of patients in terms of health status during the 1st line of treatment.

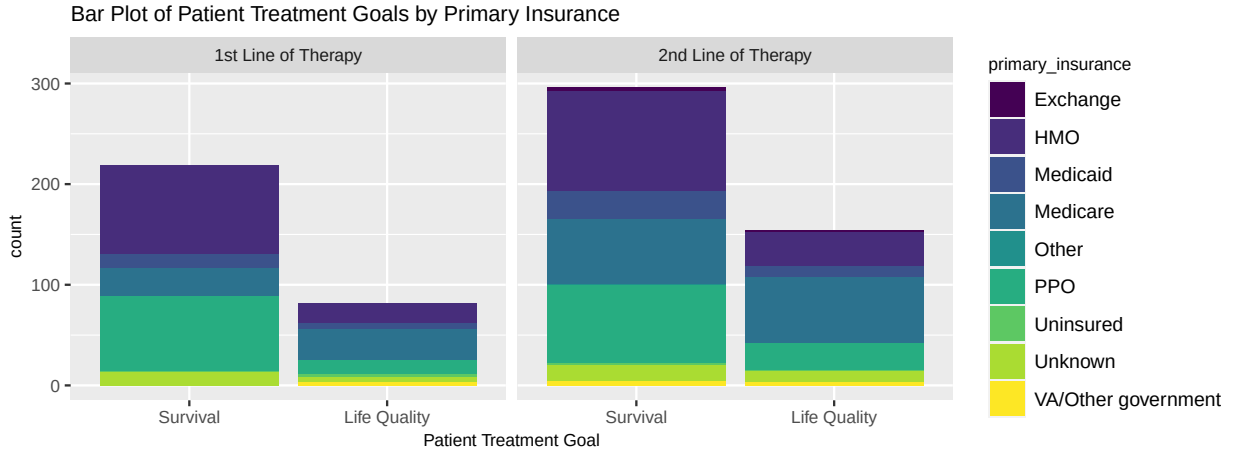
For those on 2nd line of treatment, ECOG 2 and 3 relatively evenly split the predominant proportions of patients, indicating that many of these patients have moderate functional limitations. This is followed by ECOG 0 and ECOG 3. This pattern suggests that as patients progress to the 2nd line of treatment, there is a broader spread of functional status, with a noticeable number of patients in both moderate and more severe categories.

Visualizations - Demographics, Treatment Line, Patient Involvement, Treatment Goals

In strategizing market entry, understanding patients' involvement levels and their treatment objectives is pivotal for anticipating demands and pinpointing potential therapeutic niches.







As indicated by the provided graphs:

- **Age at Diagnosis:** This parameter remains consistent irrespective of therapy lines and gender, suggesting that age might not be a primary differentiator in this market.
- **Primary Insurance Dynamics:** While the choice of primary insurance is influenced by patients' involvement levels and treatment goals, it remains uniform across different therapy lines.
  - For patients with medium to high involvement levels and a primary focus on survival, HMO, PPO, and Medicare are the prevailing insurance choices.

  - Conversely, Medicare emerges as the dominant insurance for those with low involvement levels, particularly for patients prioritizing quality of life.

- **Socioeconomic Implications:** The types of primary insurance often serve as proxies for patients' socioeconomic backgrounds. For instance:
  - Medicaid typically caters to a younger demographic, specifically those under 65 with constrained financial resources.
  - Medicare predominantly targets the senior population aged 65 and above.

In light of these insights, it's evident that insurance dynamics, potentially steered by demographic factors, play a crucial role in this market. Recognizing and leveraging these variations will be instrumental in fine-tuning our client's market segmentation strategy.

Key Findings and Points to Consider:

1. **Patient Demographics:** GBM primarily affects adults, with a mean age at diagnosis of approximately 57 years.
2. **Treatment Regimens:** TMZ mono is the most popular regimen for the 1st line of therapy. Avastin mono is the preferred choice for the 2nd line of therapy.
3. **Genetic Factors:** Multiple genetic mutations influence treatment decisions, with a significant portion of patients having unknown genetic statuses.
4. **Patient Insurance and Socioeconomic Background:** Types of primary insurance, including Medicaid and Medicare, offer insights into the patients' socioeconomic backgrounds.

Opportunity Analysis:

1. **Diverse Study Requirement:** Since 75.1% of participants are White, there's an opportunity to focus on more diverse clinical studies to provide a comprehensive view of GBM across races.
2. **Genetic Mutation Treatments:** Given the significant proportion of patients with unknown genetic statuses, there's potential in offering more genetic testing or therapies that cater to known mutations.
3. **Addressing the 2nd Line of Therapy:** With Avastin mono being the preferred choice, new drug combinations or therapeutic solutions could be researched for 2nd line treatments.
4. **Younger Demographic Engagement:** With Medicaid catering to a younger demographic under 65 with constrained financial resources, there's an opportunity to offer specialized programs or financial aid to this segment.

Recommendations:

1. **Diversify Clinical Trials:** The client should consider diversifying clinical trials, ensuring broader racial and ethnic representation, thus allowing for treatments that cater to a broader patient base.
2. **Expand Genetic Testing:** Advocate for and possibly offer genetic testing services for patients to determine mutation statuses. This will help in personalizing treatments more effectively.
3. **Engage Insurance Providers:** Build partnerships with insurance providers, especially Medicaid and Medicare, to potentially offer more affordable treatment options or payment plans.
4. **Patient Education:** Develop and implement educational programs, particularly targeting the younger demographic and those with low involvement levels. This can aid in early diagnosis and treatment adherence.
5. **Therapeutic R&D:** Invest in research and development for treatments targeting specific genetic mutations like MGMT methylated or EGFR mutated.
6. **Socioeconomic Support Programs:** Establish support programs for patients under Medicaid, focusing on financial aid, counseling, and other support services.