**Title: Business challenges of Stem Cell Technologies for Glioblastoma in New York, US**

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[Name of student]"

# Abstract

This research was based on the critical discussion on stem cell-based glioblastoma care in terms of a business management perspective. Through this study, the possible business challenges of the stem cell-based therapy for glioblastoma care were analysed. In LR section, it shows that increased funding for research and development in conjunction with clinical trials was crucial for the development of stem cell-based therapies for glioblastoma. This research assesses the funding for US glioblastoma research and its projected expansion over the next few years. This study was primarily driven by positivist philosophy, deductive research technique, and descriptive design to achieve the research purpose and collect quantitative data on business challenges connected to the treatment of glioblastoma utilising stem cell therapy. The outcomes are attained following the conclusion of the data analysis procedure. The questions that will be investigated are chosen considering the findings, which are relevant to the study's objectives. Due to the significant likelihood of recurrence following conventional multimodality therapy, which comprises surgery to remove the original tumour, concomitant radiation therapy, and adjuvant TMZ chemotherapy to destroy any cancer cells still present, GBM was considered incurable. Glioblastoma spreads into the neighbouring brain as it gets larger. Social and medical ethics limit acceptance and undermine effective commercial management. Therefore, iPSC ethical issues must be considered for more important research and duties in society. To assure trust and consumer attention, as well as corporate growth, ethics, and permission forms, are taken seriously. The multiple stages of stem cell genesis call for significant financial support and cost control. Another conclusion was that controlling internal stability can be accomplished by the division of budget plans according to the importance of corporate operations. Research and inventory management are more crucial factors because it offers medical services. When it comes to patient treatment, viable cell lines are used, and those are kept alive through the pricey process of cryopreservation. Budgeting and sectional prioritisation will therefore lessen operational challenges in the medical care industry. There will need to be legislation to regulate the spread of regenerative stem cell therapies globally, advancements in the therapeutic manipulation of stem cells, and validation of these technologies in randomised clinical trials. In addition, there was a huge demand for research to assess the cost of treatments because it is the most important for delivering improved medical care to society.

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# CHAPTER 1: INTRODUCTION

## 1.1. Introduction

This dissertation aimed at finding the business challenges of the development and implementation of Stem cell technologies for Glioblastoma in New York, USA. Through defining the problem statement, the research objectives are designed which will help this study to know more about glioblastoma.

## 1.2. Background

Stem cell Therapy is one of the novel and innovative approaches which is used for the treatment of chronic diseases. The therapy uses stem cells to regenerate damaged tissue. The therapy is currently assessed to treat chronic conditions such as liver disease, pancreatitis, and spinal cord injury including cancer (Chu et al., 2020). According to Ceccarelli et al., (2020), Stem cell Therapy is an innovative process of treatment that uses stem cells to help treat various conditions. Stem cells are unique cells that can divide and grow indefinitely, which makes them a powerful tool for treating diseases like cancer. STEM CELL Therapy is a new treatment, and people still do not know much about it (Yamanaka, 2020). However, the research that is currently being done is paving the way for future therapies that could help many people.

Stem cells have been referred to be everything from miracle medicines to panaceas. Unreliable suppliers provide stem cell treatments that are untested and unregulated which can be harmful enough for patients. So before contemplating any treatment, be cautious of potentially risky procedures and be sure the patients are receiving what is being given. From cord blood, stem cells are isolated and only used as stem cell-based products with FDA approval in the United States (FDA, 2023).

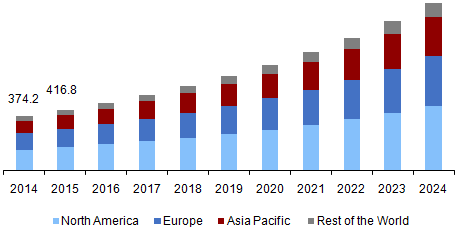


Figure 1.1: Revenue from the global glioblastoma multiforme market, by region, from 2014 to 2024 (USD Million)

(Source: HEXA research, 2023)

A particularly aggressive kind of brain cancer that is extremely difficult to cure is glioblastoma. However, there are various treatments available that are thought to be quite successful in some cases (Zhu et al., 2019). One such treatment is stemming cell therapy. Moreover, in Figure 1.1, the market for glioblastoma multiforme (GBM) a 2016 estimate of USD 464.8 million and is anticipated to increase dramatically over the coming years, mostly because of the ageing global population. GBM strikes people between the ages of 45 and 65 (HEXA research, 2023, Amarandi et al., 2022). However, GBM treatment is one of the costliest processes in the US, the estimated monthly direct cost per patient for the treatment of GBM is $8500, primarily made up of surgical, imaging, and radiotherapy charges. According to Amarandi et al. (2022) the direct costs of hospitalisation and medical care differ by country, averaging 27,000 USD per patient in Sweden and 95,000 USD per patient in the US. Indirect GBM costs are often much higher than direct GBM expenditures, with predicted charges of 112,000 $/patient in Spain and 101,000 $/patient in Sweden. In addition, there is a drive towards bundled treatment and more straightforward payment structures as the cost of cancer care in the US rises. To administer healthcare effectively, decisions about actual payments and expenses for glioma care must be based on accurate data. Also, Liu et al., (2019) revealed that patients with commercial insurance had greater survival times than those with non-commercial insurance. For treating care of this sensitive brain cancer, the New York government need to invest more and help patients to get proper treatment using futuristic approaches such as stem cell therapy and robotic detection (Vargas-Toscano et al., 2020). Advanced New York Regenerative Medicine is one of New York City's most well-known stem cell clinics (Gampel et al., 2020).

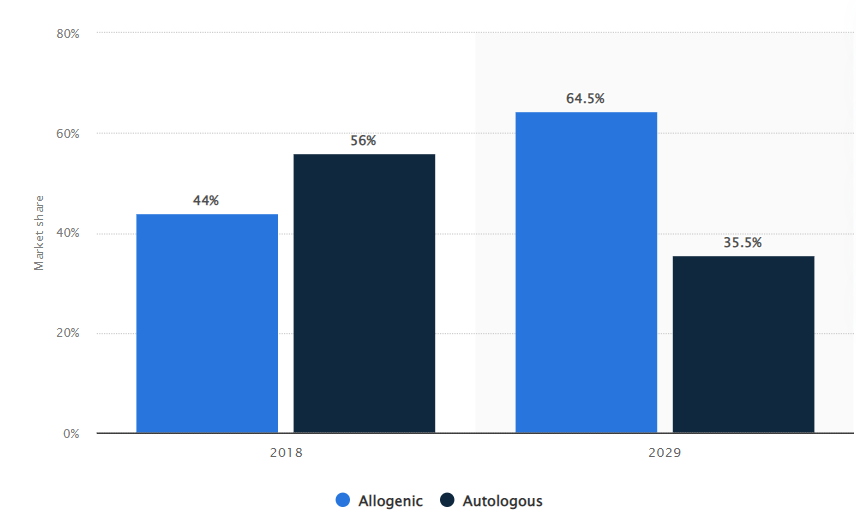


Figure 1.2: Global stem cell therapy market share in 2018 and a forecast for 2029

(Source: Statista, 2023)

Glioblastomas (GBMs), which account for 54% of all gliomas, make up the bulk of 16% of all malignant brain tumours, making up primary brain tumours (Tamimi et al., 2017). After a surgical resection is carried out as securely as possible to start the complicated treatment process, concomitant chemotherapy with temozolomide is administered (TMZ). In contrast, stem cells are not connected in the current situation. In 2018, the market for treatment with stem cells was expected to be worth about 755 million US dollars overall. It is predicted that the market will have a net worth of about 11 billion dollars by 2029 (Statista, 2023). In 2016, the United States accounted for over 36% of the global market (Statista, 2023). By 2027, it is projected that the Latin American market for stem cell assays will have increased by 150%, from 112.71 million dollars in 2022 to 281.64 million dollars (Statista, 2023).

## 1.3. Problem Statement/Research Rationale

***What is the issue***

Stem cell therapy is a risky and potentially life-threatening procedure with high-cost values. Selecting an experienced provider is the greatest approach to guarantee the security of stem cell therapy (Chaicharoenaudomrung et al., 2019). In terms of business administration, there are specific limitations for glioblastoma and stem cell therapy as both are expensive and need more research before implementation in patient care. Governing bodies of New York along with stem cell companies and cancer research institutes face budget issues due to the pandemic and recession (Nytimes, 2023). There are a few issues with stem cell therapy in the USA. The main one is that there is a lot of variety in the quality of stem cells being used and that the therapy is not yet standardised. This means that some people may not get the best possible results from the therapy.

***Why it is an issue***

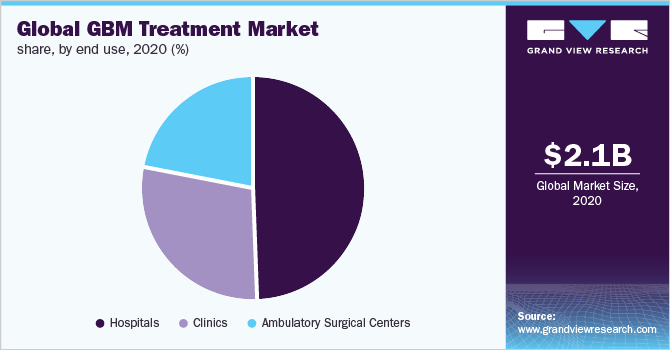


Figure 1.3: Global GBM treatment market

(Source: Grand view research, 2023)

According to 1.3, the market for treating glioblastoma multiforme is expected to reach 2.14 billion USD in 2020 and from 2021 to 2028, it will expand at a CAGR of 8.8% (Grand view research, 2023). Due to several variables, including increased R&D, the rising incidence of glioblastoma multiforme, and favourable regulatory settings, the market is anticipated to grow. However, there are limitations to getting the highest positive responses for stem cell therapy in glioblastoma which can reduce the market size and innovation in the healthcare system. In the upcoming years, the market is anticipated to be driven by the rising acceptance of innovative therapies and combination therapies. For instance, Pfizer's Zirabev, a biosimilar to Avastin, was approved by the American Food and Drug Administration in June 2019 for the treatment of recurring cancers like NSCLC, colorectal cancer, and glioblastoma. The firm introduced its product in the United States in January 2020 (Grand view research, 2023). Moreover, during a pandemic, global health stakeholders' investment in the New York healthcare system fell and it created a crisis for innovation in stem cell therapies for glioblastoma (Micah et al., 2023). Hospitals dominated the market with a 49.2% share in 2020, and it is anticipated that they will hold that position throughout the forecast period.

***Why it is an issue now***

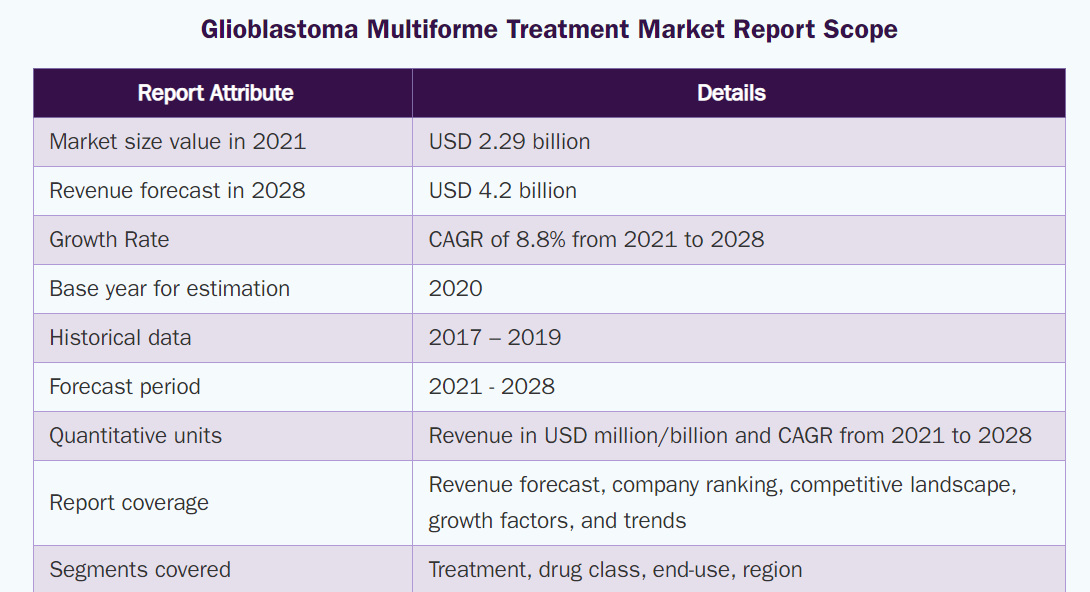


Figure 1.4: Glioblastoma Multiforme Treatment Market Report Scope

(Source: Grand view research, 2023)

As per Figure 1.4, the target approach for glioblastoma treatment is getting higher and this increases the importance of research in stem cell therapy for glioblastoma as a novel approach (Grand View Research, 2023). Current issues are detected for success rate in stem cell therapy for glioblastoma which is near about 9% but the rate of failures is more impactful due to high cost (World economic forum, 2023).

***What does the research shed light on***

This research will enhance the knowledge regarding glioblastoma and the treatment of glioblastoma through stem cells. Moreover, it will highlight the point of success rate and biochemical connections to reduce the pathogenicity of glioblastoma.

## 1.4. Research Questions

* What is the analysis of the development of stem cell technologies for glioblastoma in New York, US?

## 1.5. Research Aim and Objectives

**Aim**:

This dissertation aimed at identifying the business challenges for the development and implementation of Stem cell technologies for Glioblastoma in New York, US.

**Objectives**:

* Understand contemporary theory on business challenges for stem cell development technologies for Glioblastoma in New York, US
* Appreciate the importance of identifying business challenges for the development of Stem cell technologies for Glioblastoma in New York, US.
* Determine the business challenges for the development of Stem cell technologies for Glioblastoma in New York, US.
* Draw conclusions based on the above objectives

## 1.6. Significance of the Research Topic

STEM Cell Technologies is significant as they have the potential to revolutionize the way to live and work. These technologies have the potential to enhance everyone's quality of life by offering fresh, innovative approaches to treating illness and increasing the effectiveness of jobs that are now undertaken. Glioblastoma accounts for about 16% of all primary brain cancers and most of the time they are not treated properly (Goel et al., 2021). It is resistant to many common treatments, including radiation and chemotherapy. This research topic enriches modern medicine through innovative and informative knowledge of critical brain cancer but faced business administrative issues while implementing it in the New York healthcare system. Moreover, through stem cell therapies there is less scope for side effects than chemotherapy and radiation therapy. Hence, statistical, and pathophysiological concerns of glioblastoma can enhance the research perspective which supports stem cell therapy throughout the globe (Lassman et al., 2020). In New York, there is ample scope to conduct research on glioblastoma and stem cells as the scope of research and cases is high.

## 1.7. Structure of dissertation

## 1.8. Summery

This chapter concludes that stem cell research and implementation for chronic disease care needs more research which can help with glioblastoma treatment. Moreover, there are huge expectations from the stem cell therapy market but due to failures and high cost, the research is not moving forward to increase sustainable treatment. More involvement of stakeholders and investors is required to update the innovation in medical implementation for glioblastoma. Furthermore, the market for stem cell therapy has great expectations, but due to mistakes and high costs, research was not progressing to expand sustainable treatment. Study shows innovation in the medical application for glioblastoma needs to be updated, and more stakeholders and investors need to get involved.

# CHAPTER 2: LITERATURE REVIEW

## 2.1. Introduction

The business of stem cell technologies for glioblastoma is a growing field with significant potential for both healthcare providers and investors. As a result, many biotech firms are creating technologies and medicines for glioblastoma based on stem cells. Investment in stem cell technology companies focused on glioblastoma is also increasing, with many venture capital firms and private equity investors showing interest in this area (Allsopp et al., 2019). Additionally, to develop and market novel treatments for glioblastoma, pharmaceutical companies are collaborating with stem cell technology firms. However, there are also significant challenges facing the business of stem cell technologies for glioblastoma. One of the biggest challenges is the high cost of developing and bringing new therapies to market. The FDA requires thorough safety and efficacy evidence before authorising new medicines for use in commercial settings, making the regulatory environment for stem cell-based therapeutics complex and constantly changing (Jiang et al., 2014). Despite these challenges, the potential benefits of stem cell therapies for glioblastoma make it an area of significant interest for both healthcare providers and investors. Researchers may anticipate continued innovation and investment in stem cell technology for glioblastoma as the field develops and grows.

## 2.2. Different factors that impact the Business of Stem Cell Technologies for Glioblastoma

It has been shown that mesenchymal stem cells (MSCs) and induced NSCs (iNSCs), which are generated from pluripotent stem cells, aid in healing and have tumour-promoting properties. They are widely dispersed in brain gliomas as well. Calinescu et al., (2021) stated, Numerous preclinical studies have looked at these cells' capacity to spread throughout the tumour and deliver a variety of therapeutic agents, such as toxins, cytokines, bioactive proteins, antibodies, viruses, or nanoparticles. Although some of these experiments used rat stem cells, most of them examined the use of human stem cells (Kong et al., 2021). Human NSCs that have been immortalised were used the most frequently, followed by MSCs that were extracted from adipose tissue, bone marrow, umbilical cord, or amniotic fluid (Beiriger et al., 2022). In the study of Spencer et al., (2019), iNSCs that had undergone trans differentiation from fibroblasts were also used. The biggest safety issue with therapeutic NSCs is their propensity to produce cancer, especially when implanted into patients' brains who have developed tumours that provide an environment permissive to tumour growth. In contrast to induced pluripotent stem cells, iNSCs were demonstrated to be safe in this regard and did not promote cancer growth in a syngeneic mouse model that produced aggressive, lethal tumours (Calinescu et al., 2021; Matarredona et al., 2021). iNSCs have not yet been examined for GBM in a clinical setting.

In stem cell-based therapy for GBM, the delivery strategy must be carefully addressed to guarantee that enough cells can reach the tumour and provide therapeutic benefits. It has also been demonstrated that intraventricular injection produces a good intratumorally dispersion of stem cells. Calinescu et al., (2021) observed Quantitative analyses and three-dimensional (3D) reconstructions of the dispersion of NSCs in mice after intraventricular injection showed that these cells moved quickly towards tumours, even when the lesions were multifocal and dispersed across hemispheres. It is invasive to administer stem cells locally to the brain, and difficulties could arise from repeated delivery (Moore et al., 2020; Fan et al., 2022). Intranasal delivery is a promising alternative method for the non-invasive delivery of therapeutic stem cells. The olfactory or trigeminal nerves can be delivered via the perivascular pathway within the central nervous system (CNS) by using this technique to get around the blood-brain barrier's (BBB) limitations on movement and authorization of therapeutic cells after systemic administration. This is possible due to the architectural and physiological characteristics of the nasal mucosa.

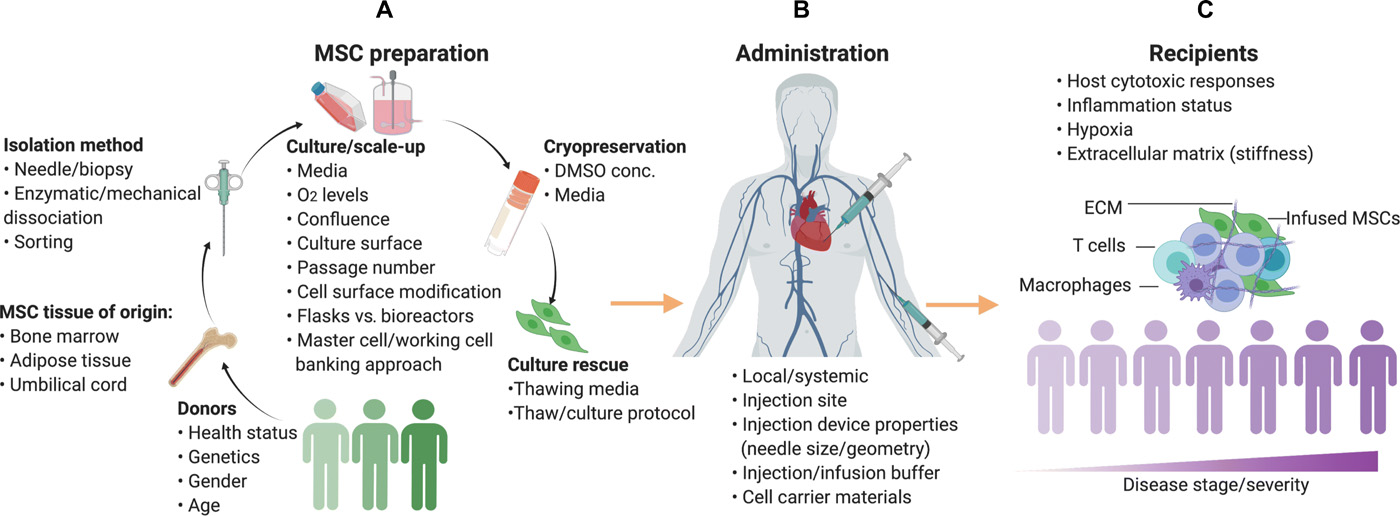


Figure 2.1: Major factors affecting the heterogeneity and ultimately the clinical outcome of MSCs

(Source: Levy et al., 2020)

Factors associated with this process in terms of business perspectives include cost for stem cell collection, cellular growth, and proper implication by modulating their potencies. The potency of MSCs can vary depending on the donor, including their health status, genetics, gender, and age (Nowak et al., 2021; Tu et al., 2020). The potency of MSCs can also be impacted by various techniques used to separate cells from these tissues and acquire cells. Potency and homing are claimed to be influenced by the culture circumstances, which also include the medium's composition, culture surface, confluence, oxygen concentrations, flasks or bioreactors, and cell surface modification. Finally, the survivability, functioning, and homing of MSCs can be impacted by cryopreservation and thaw/culture rescue methods (Bahsoun et al., 2019). However, outlines the key factors involved in the administration of MSCs that can have an impact on the success of the therapeutic process. Route of administration, injection site, characteristics of the injection device, the injection/infusion buffer, cell carrier, residence period, viability, and homing of MSCs can all be impacted. On the other hand, C in Figure 1 outlines the key MSC recipient-related parameters that can influence the course of treatment (Levy et al., 2020). It has been demonstrated that the effectiveness of the therapy is strongly correlated with host cytotoxic responses against MSCs (Wang et al., 2023). According to the analysis of Xu et al., (2019) the host disease or severity affects the treatment result as well, which can lead to highly varied microenvironmental variables inflammation state, hypoxia, and ECM that influence MSC activity.

The business of glioblastoma is complex and multi-layered. The primary source of revenue for glioblastoma companies is the sale of anticancer drugs and treatments. These companies must also develop new treatments and therapies as medical technology advances and often partner with other cancer research institutions (AANS, 2023). Glioblastoma patients and their families are also important market participants.

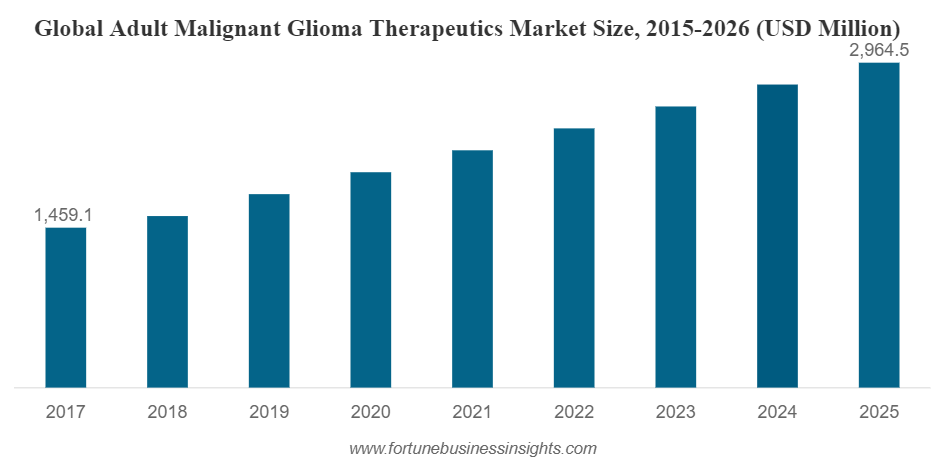


Figure 2.2: The Global Adult Malignant Glioma Therapeutics market size

(Source: Fortune business insights, 2023)

With a CAGR of 9.3%, it is predicted that the market for treatments for adult malignant gliomas, by the end of 2026, which had a value of USD 1,459.1 million in 2018, will reach USD 2,964.5 million (Fortune business insights, 2023). The market for adult malignant glioma therapeutics is expected to grow at a rate of close to two per cent Compound annual growth rate (CAGR) the market is anticipated to expand over the projected period due to favourable government and regulatory policies that encourage the development of imaging technology breakthroughs that enable early disease diagnosis and favourable Policies governing glioma product reimbursement over the world (Stylli, 2020; Arevalo et al., 2019). Glioblastoma multiforme (GBM) accounted for the biggest treatment market share for adult malignant gliomas in 2018. Throughout the projected period, the category is likely to maintain its leadership. The category of the hospital accounted for a sizable market share in terms of end users. However, due to the availability of medical services specifically designed for cancer treatment, the sector for cancer and radiation therapy centres is anticipated to grow at the greatest CAGR over the projection period (Fisher and Adamson, 2021).

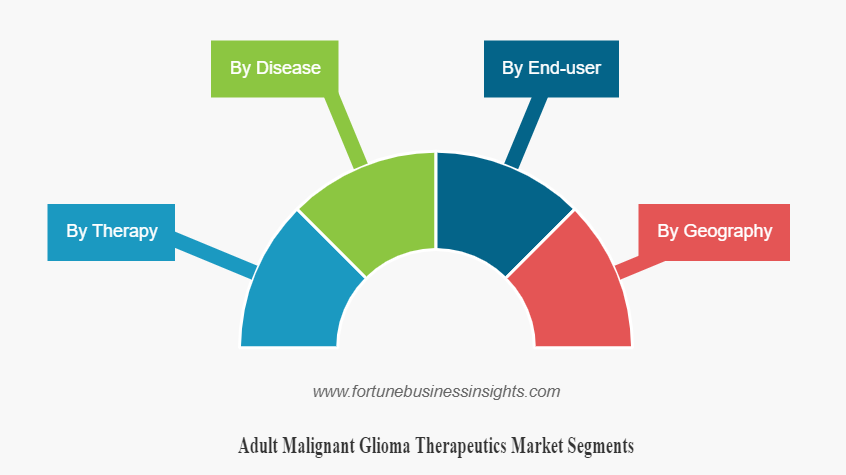


Figure 2.3: Market Segmentation for adult malignant glioma therapeutics

(Source: Fortune business insights, 2023)

There are many ways to market malignant glioma therapeutically. One way is to focus on different target markets. Another way to market malignant glioma therapeutically is to focus on different treatment goals. For example, some patients may be more interested in eradicating the tumour, while others may be more interested in reducing the tumour size. The most prevalent form of brain cancer, malignant gliomas, make up around 20% of all brain tumours (Mulcahy et al., 2020; Rahman et al., 2023). There is no known cure for malignant gliomas, but current therapies are effective in treating cancer. Chemotherapy, radiation therapy, and surgery are presently used to treat malignant gliomas. Surgery is the most common approach and removes the tumour. Cancer cells are treated using chemotherapy and radiation therapy. Both radiation therapy and chemotherapy use chemicals to destroy cancer cells by damaging them with high-energy beams (Grand view research, 2023).

## 2.3. Challenges Faced by Stem Cell Technologies for Glioblastoma with business perspectives

The use of stem cell technology has the potential to completely change how many diseases are treated, but they are also fraught with difficulties. This is particularly difficult for adult stem cells, which are difficult to grow in large numbers and can sometimes cause complications when transplanted into the body. The lack of regulatory permission for new cell types is one of the main problems facing the stem cell manufacturing sector. Although mesenchymal stem cells and erythropoietin-producing cells are used in regenerative medicine treatments, they have not received regulatory approval (Bapst et al., 2022). The difficulties that cannot be resolved using traditional analytical processes created for low-molecular-weight medications or other biopharmaceuticals are another component of the difficulty that is being faced globally during the development of stem cell therapy (Zhang et al., 2022). Chemical sensitivity in stem cells is high. Treatment given during or after a transplant for a variety of typical reasons, such as transplant rejection or a decline in immunity at the time of the transplant, can occasionally have an impact on the delivered stem cells. Safety is always a top priority, especially given that this type of therapy may address serious illnesses. Along these lines, producers ought to address the consistency of the goods they make. Several people are also concerned by the FDA warning, which even refers to stem cell therapies as being against the law.

The average cost of imaging during glioblastoma treatment was $2,788–3,719. Several therapy techniques were combined in studies. In investigations by Goel et al., (2021), the use of the contemporary treatment paradigm resulted in an average cost of $62,602 and 16.3 months of survival. Indirect costs are those incurred by the patient or family that are not directly related to paying for the treatment or medical care. Other writers have attempted to calculate the indirect costs of GBM while taking into consideration death, early retirement, and sick leave. Cagney and Alexander, (2017) calculated that the overall annual indirect expenditures for the Swedish population came to $22.5 million per million. Mortality rate made up 73.1% of the indirect expenditures for patients under 65. Hence the cost of care for critical brain cancer is huge and restricts patients to invest a lot of money in a better life.

Levy et al., (2020) opined, these difficulties can be categorised into three groups: difficulties associated with MSC production (Fig. 1A), difficulties associated with MSC administration (Fig. 1B), and difficulties associated with recipients (Fig. 1C). By highlighting several instances where bioengineering solutions are used to address the clinical issues created by MSC administration, administration, product quality, and host factors, it can be concluded that bioengineering techniques ought to be applied to create more effective and predictable MSC therapies.

## 2.4. Strategies undertaken by healthcare organisations to improve Stem Cell Technologies for Glioblastoma

The study of stem cells is a new area that is expanding quickly. Stem cells are being used in a variety of new ways to treat diseases and ailments, according to researchers. The body's stem cells can develop into any form of cell. They are important because they can renew damaged cells and help maintain overall health. There are many ways to use stem cells in research. One way is to use stem cells to treat diseases or conditions. Scientists are also using stem cells to study diseases. Stem cell research is a rapidly growing field that is constantly evolving (De Luca et al., 2019). Sun Pharma is actively engaged in this field and has been conducting stem cell research for over a decade.

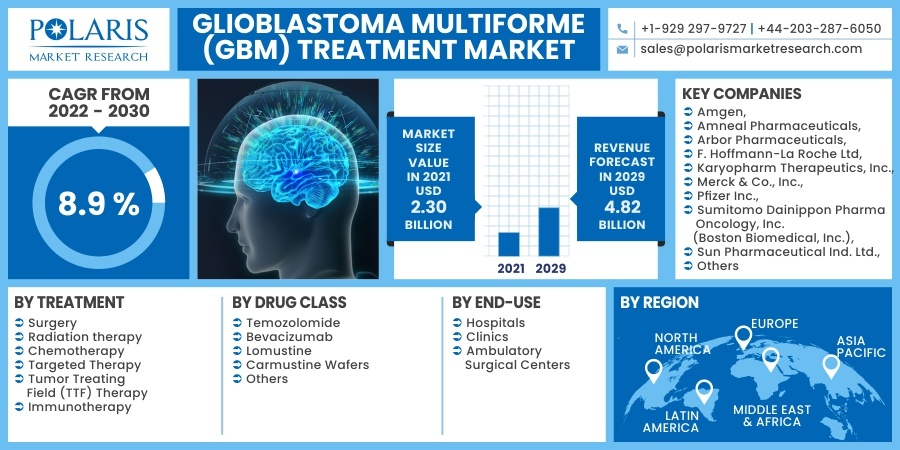


Figure 2.4: The glioblastoma multiforme (GBM) treatment market

(Source: Polaris market research, 2023)

Various donor stem cell modification strategies are currently available. The GBM is a tumour that originates from the cells of the brain and can grow quickly. Treatment for GBM typically includes surgery, radiation therapy, and chemotherapy. The treatment options available for GBM are limited, and new treatments are being developed all the time. The GBM treatment market is large and growing rapidly. By 2021, it is anticipated that the market would have increased from $2.2 billion in 2016 (Research and Markets, 2023).

In 2020, North America held the largest share with 43.6% (Grand view research, 2023). Some of the major drivers propelling the regional market growth include government backing for the expansion of the healthcare industry, increasing awareness of uncommon illnesses, easy access to world-class healthcare facilities, and generous reimbursement policies. Because of several factors, including the release of generic versions of temozolomide, an improving economy, an increase in the number of senior people, and increased healthcare investment, Asia Pacific is predicted to expand at the fastest rate, 10.2%, throughout the forecast period (AANS, 2023). Large unmet demands in the market, increased knowledge of GBM, and a strong pipeline of compounds that can cross the blood-brain barrier are a few of the major variables influencing the regional market growth. Stem cell research is a rapidly growing field of medicine that is still in its early stages. Amgen is one of the leading companies working on stem cell research. They are working on several different projects to improve the treatment of diseases. Some of their projects include developing treatments for diseases like chronic pain, Parkinson's disease, and heart disease (Khatiwala and Cai, 2016). Although stem cell research is still in its infancy, it has the potential to completely change how diseases are treated.

The National Cancer Institute (NCI), a part of the National Institutes of Health, seeks to promote cancer prevention, treatment, and detection (Cancer, 2023). The NCI funds various clinical trials to assess the security and effectiveness of stem cell therapy for glioblastoma and promotes research into these treatments. A non-profit organisation called the Brain Tumour Foundation is committed to raising the standard of living for people with brain tumours and their families. The group provides funding for studies into innovative glioblastoma therapeutics, such as stem cell therapy. A global organisation dedicated to developing stem cell research and its uses in healthcare is the International Society for Stem Cell Research (ISSCR) (ISSCR, 2023). The group offers advice on the best ways to conduct clinical trials and funds studies into stem cell treatments for glioblastoma. A professional association for those working in the field of cancer research and healthcare is called the American Association for Cancer Research (AACR). In addition to funding research into new glioblastoma therapies, including stem cell therapy, the foundation also offers resources and education to advance the profession. A state-funded institution dedicated to advancing stem cell studies and treatments is the California Institute for Regenerative Medicine (CIRM). The organisation funds clinical studies in this field and promotes research into stem cell treatments for glioblastoma (CIRM, 2022). These healthcare institutions support clinical studies, fund research, and disseminate information to advance stem cell treatments for glioblastoma. Together, they can progress the field and provide glioblastoma patients with new, potent treatments.

The GBM treatment market involves medical devices along with different medical products which are effective for patient care of Glioblastoma. The market size for GBM treatments is difficult to estimate, but some reports suggest that it could reach $3 billion or more by 2025. Several companies are developing new treatments for GBM, including immunotherapies, targeted therapies, and gene therapies. According to Wilson et al., (2014), In GBM, stem cells have been investigated as delivery systems for gene treatments. Neural, embryonic, and mesenchymal stem cells are the three types of stem cells being investigated as GBM vectors. The intrinsic tumour trophic characteristics of stem cell vectors make them appear attractive because they might improve the transfer of genetic material to tumour cells and boost treatment effectiveness. Some of the major participants in the market for treating GBM include Merck & Co., Inc., Bristol-Myers Squibb Company, Novartis International AG, and Roche Holding AG. As per figure 2.4, the market revenue might rich to 4.82 billion USD by 2029 which enhanced the market of glioblastoma for more critical research and development (Polaris market research, 2023). As such, the development of new and effective treatments for GBM remains an area of active research and investment.

Research is currently being conducted to examine the potential of stem cells to treat GBM, which is a disease. One approach involves using stem cells to deliver targeted therapies directly to the tumour. Stem cells can be engineered to produce specific proteins or drugs that can kill cancer cells, and then delivered directly to the tumour site (Matarredona and Pastor, 2019). This approach can help to minimise damage to healthy brain tissue and reduce the risk of side effects associated with traditional therapies. Stem cells can be modified to express proteins that activate immune cells to recognize and attack cancer cells, and then injected into the patient's bloodstream (Prager et al., 2020). Overall, stem cell therapy shows great promise in the treatment of GBM, but much more research is needed before it can become standard practice (Zhu et al., 2019).

## 2.5. Research gap & conceptual framework

Goel et al., (2021) failed to conduct a thorough economic analysis of the costs of adjunctive treatment, recurrence costs, and standards of care. Different authors Allsopp et al., (2019), Limitations should be shown for the overall costs of culture and sophisticated differentiation procedures, which may demand long periods of labour, medium, and supplements and have a high danger of contamination. Levy et al., (2020) demonstrate constraints in process development, including observed errors in characterisation, cell delivery, and thawing variability, which is crucial for ensuring that all techniques are reliable, effective, and capable of producing the desired results in a repeating manner. The business research done by Polaris focused on the business aspects of glioblastoma with research organisations but had not included the cost of research for glioblastoma. Implication costs are derived in detail but not the research cost. Wilson et al., (2014) stated the gene delivery system for stem cell therapy but not specified to glioblastoma which is the focus for this study. However, the information on stem cell therapy will help to analyse the complications initiated through oncogenes.

**DEVELOPMENT OF STEM CELL TECHNOLOGIES FOR GLIOBLASTOMA IN NEW YORK, US**

**Factors that impact the Business of Stem Cell Technologies for Glioblastoma**

**Challenges Faced by Stem Cell Technologies for Glioblastoma**

*Cost for stem cell collection, cellular growth*

*Cryopreservation and thaw/culture rescue methods*

*Overestimating Synergies*

Lack of regulatory permission

Chemical sensitivity in stem cells and difficulties associated with MSC administration

*High cost and research demand*

**Strategies undertaken by healthcare organisations**

**Market Segmentation for Glioblastoma**

High-quality medical facilities

Inclusion of pharmaceuticals, medical devices, and other products and services

Targeted therapies

By Therapy

By disease

By geographical identity

**Clinical trials for positive outcomes of stem cell-based glioblastoma care to enhance the business opportunity in the long run**

## 2.6. Summary

Thus, it can be summarized that more investment in terms of research and development with medical trials is important in stem cell-based treatment for glioblastoma. Moreover, there are governing and non-governing authorities who are supporting this research for medical advancement and enhancing the treatment procedure with the non-pharmacological process. Strong energy beams are used in radiation treatment for brain tumours to kill tumour cells. The energy may originate from protons, X-rays, or other sources. Brain tumour radiation treatment typically originates from a machine outside the body. Radiation therapy for brain tumours normally comes from a machine outside the body. This was referred to as external beam radiation. Physical and cognitive capacities may be impacted by glioblastoma. These abilities can be enhanced by cognitive and physical treatment, which can also assist patients in more effectively navigating the difficulties of their illness. In addition to all these non-pharmacological remedies, stem-based healthcare is one of the personal care approaches that was studied. It offers patients specialised gene treatment using stem cells as a delivery vehicle. Due to sociological and environmental problems, this problem's market size was growing, but effective treatment will improve the medical service plan.

The term for this is exterior beam radiation. Glioblastoma can affect cognitive function and physical abilities. Cognitive and physical therapy can help to improve these functions and help patients to better cope with the challenges of the disease. Besides all these non-pharmacological treatments there is another way that is under research; stem-based care. It provides patients with targeted gene therapy using stem cells as a vector. This chapter evaluates the budget of US research for stem cell-based glioblastoma care and its growth in the coming years. The market size of this issue is getting higher due to societal and surrounding issues but proper treatment will enhance the medical service plan.

# CHAPTER 3: METHODOLOGY

## 3.1. Introduction

This chapter covered the goals, strategies, and developments of a research methodology with a clear research philosophy and design that can aid in the collection of data with a particular focus. To enhance the operational quality of this study, a critical discussion of the research methodology and data collection process is conducted. The stages necessary for carrying out the research activity are included in Saunders' research onions, which were created by Saunders in 2007 (Al-Ababneh, 2020). Each layer of the structure provides more information about each stage of the process, giving the structure the appearance of an onion.

## 3.2. Research philosophy

The positivist philosophy must be based on reliable facts and information that have been gleaned from studies. As a result, in positivist philosophy, the researcher only gathers restricted amounts of evidence and gives it an objective interpretation (Park et al., 2020). In essence, the findings were observable and quantifiable because the researcher had to be an objective analyst for gathering information on Glioblastoma and stem cell therapy's impact on it. Statistical analysis will follow from this quantified analysis (Lam et al., 2022). The interpretive research perspective underlines the value of interpretation in the research process (Junjie and Yingxin, 2022). A more precise and thorough knowledge of the study situation than can be attained using conventional approaches is what interpretivism seeks to achieve. The foundation of interpretivism is the idea that the researcher constantly engages with the social context in which the study is conducted and that this context always affects how the researcher interprets the findings (Curry, 2021). Instead of forcing the person conducting the study to rely on a preconceived interpretation, interpretivism aims to let the researcher grasp the data in the context in which it was acquired.

The study objectives can be selected to be interpreted using the positivist philosophy (Marsonet, 2019). Investigating the effects of stem cell therapy for Glioblastoma can be done by integrating the positivist philosophy. It has been established that the use of positivity can aid in determining the success factors for stem cell therapy for Glioblastoma. Positivism holds that beliefs or theories that cannot be corroborated by personal experience or direct observation do not constitute true knowledge (Alharahsheh and Pius, 2020). As a result, it may be argued that comprehension of a text is a dynamic, ever-evolving process. For glioblastoma and stem cell therapy, it has been used to research a variety of subjects, including the nature of interpreting and the reader's place in society. Interpretivism has enormous advantages for both philosophy and critical theory.

## 3.3. Research Approach

When the market is large, it is practical to apply the deductive approach. The deductive approach was thought to be the most effective strategy since it allowed for the finest understanding of how online advertising affected such a wide range of consumer shopping preferences. It involves a fact-based, logical approach that aids the researcher's practical conclusion-making. The method, which has a logical foundation, is mostly employed in scientific and mathematical research (Benitez-Correa et al., 2019). An organised strategy for analysing qualitative data, the inductive technique is probably driven by certain evaluative goals. It is sometimes claimed that qualitative research employs inductive thinking since it shifts from exact observations about specific cases to greater generalisations and ideas. To analyse innovative ideas or learn more about a topic under study, inductive research is widely used (Walter & Ophir, 2019).

The study is developed using a deductive research strategy. The theoretical framework used to analyse the study's goals will be the focus of the deductive approach. On a supportive note, the deductive research methodology will be applied in this investigation. The asset management theories will be examined using the research framework, and the effects of stem cell therapy for Glioblastoma will also be determined. The deductive method will assist in determining the purpose of stem cell therapy for Glioblastoma. As a result, it will be appropriate to incorporate the deductive technique to identify the elements that contribute to stem cell therapy for Glioblastoma.

|  |  |
| --- | --- |
| **Inclusion criteria** | **Exclusion criteria** |
| * The published articles can only be included * Language must be in English * Last 5 years articles are selected | * Any Foreign language publications other than English have been excluded. * More than 5 years of Articles were excluded from this research |

## 3.4. Research design

A scientific project is guided by a research design. It outlines the methods, resources, and procedures employed to carry out the study. It can help while conducting research and analysis by detecting and resolving potential issues. A descriptive study design seeks to describe events, situations, or populations through thorough data collection (Bloomfield and Fisher, 2019). The descriptive design is the most simple and specific of all the many observational study types. It enables the researcher to examine and study the distribution of one or more variables without taking any other causal assumptions into account. A method for planning and carrying out scientific experiments is known as an experimental research design (Rogers and Revesz, 2020). It entails defining the study's objectives, planning the experiment to meet those objectives, and then tracking and interpreting the outcomes. To test ideas or hypotheses, discover how various variables affect the behaviour of animals or materials or create new goods or technology, experimental research might be used.

The correlational study design is another method for examining relationships. In a correlational study, the relationship between two or more variables is examined (Bloomfield & Fisher, 2019). Instead of attempting to establish whether one variable causes the other, correlational research seeks to identify whether there is a connection between two variables. Using the little knowledge currently available, the explanatory investigation examines the causes of events (Casey et al., 2022). Explanatory investigations are those that use research hypotheses to characterise the kind and pattern of interconnections between or among the variables being studied. To create focused research strategies to evaluate the study objective for this significant issue, the research strategy will prove to be an invaluable instrument. The exact object of the study will be determined using the exploratory research approach. The research design for this study will be an exploratory one. This tactic will aid in the investigation of the critical elements for a successful development process. Exploratory research will make a substantial contribution to the secondary data collection technique. As a result, the strength of this project will justify the usage of an exploratory research design.

The descriptive research analysis is also more practical for this study and contributes to better research results. When investigating a subject, descriptive research is a useful tool. In comparison to other types of study, it can give a better comprehension of the subject. Descriptive research does have some restrictions, though. The disadvantage of descriptive research is that it cannot yield results that can be simplified. Therefore, a descriptive study cannot show whether the conclusions are true generally or only apply to the population or set of conditions under examination.

|  |  |
| --- | --- |
| **Database** | **Search string** |
| PubMed | Impact of Stem Cell Technologies TO Glioblastoma in New York  Role of Stem Cell Technologies TO Glioblastoma FOR Glioblastoma in New York |
| Medline | Impact of Stem Cell Technologies TO Glioblastoma in New York  Role of Stem Cell Technologies TO Glioblastoma FOR Glioblastoma in New York |
| Science Direct | Impact of Stem Cell Technologies TO Glioblastoma in New York  Role of Stem Cell Technologies TO Glioblastoma FOR Glioblastoma in New York |

**Literature Retrieval/ Library Databases**

* Science Direct
* PubMed

**Keywords**

* Stem Cell Technologies
* Business Challenges in Stem Cell Technologies
* Glioblastoma in New York

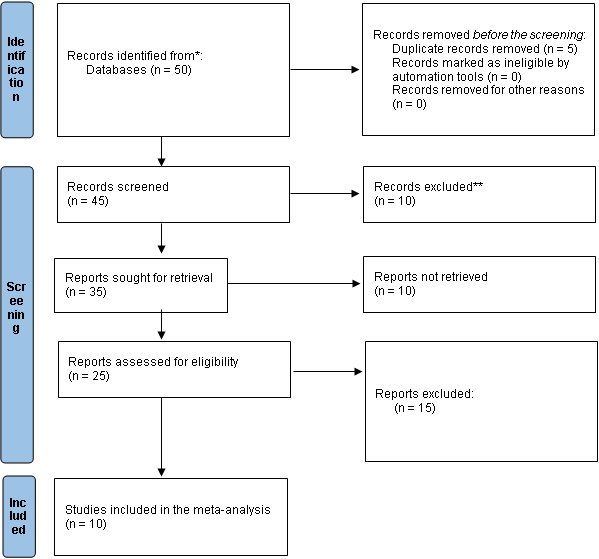
## 3.5. Research administration

The study methods section's data collection is a crucial component. The data needed for this study method was successfully acquired. To analyse the study, secondary data collecting is used. To evaluate the impact of this study, reliable information is obtained. Effective tactics increase the power of the data collection process. The secondary data gathering approach will therefore be defended as being suitable for important aspects that have an impact on stem cell therapy for Glioblastoma. The researcher employs one or more experiments, case studies, and observable qualitative and quantitative methodologies when performing fundamental research. By employing these techniques for data collection, the researcher can obtain the study's most pertinent and accurate data. Additionally, the mixed research approach, which uses both secondary and primary data, will increase the validity and dependability of the results. As a result, quantitative data will be effectively understood, resulting in important discoveries in line with the research purpose.

The research will only make use of secondary sources. Secondary research methods are chosen over primary research methods since they are less expensive but take less time. At the same time, secondary research can be finished quickly. For the dissertation, only reliable journals will be examined. In addition, information will be gleaned through books. Nonetheless, the research will only be conducted using morally sound approaches. Resources for secondary quantitative data include electoral statistics, books, journals, medical records, and other print media. These sources enable researchers to collect actual data and evaluate it using a literature review. All the data was collected from open-access resources from news articles, research articles and statistical websites which are authentic and approved by academic institutes. There are no accessibility and authenticity issues in this dissertation. However, this is verified with UK ethical consideration factors. To examine real-life occurrences, learn about efficient remedies, and alter behaviour, research that is based on human interaction and impact must take care of and maintain ethical considerations (Sim and Waterfield, 2019). Boost the research's dependability while preserving the process's scientific integrity.

Secondary data refers to information that has originated from sources other than the original user. This implies that the data has been investigated and is accessible. Secondary data refers to information acquired by a user other than the primary user. The sources of secondary data utilised in social science research include statistical information gathered from government organisations and business records.

***Prisma***



A Prisma flow diagram is used to complete the article selection process through proper keyword implementation and inclusion criteria. As per the mentioned inclusion criteria, specific articles are included and the rest are excluded from 50 articles. For analysis of the selected articles critical analysis will be followed which is effective to note the target points and outcomes from each 10 articles.

## 3.6. Research ethics

To solve the issue with the current study, secondary data analysis was done rather than collecting primary data. Only trustworthy journals will be investigated for this study based on their eligibility and exclusion criteria. Thus, there is less scope for ethical complications as most of the articles are ethically approved before publishing. Nonetheless, the research will only be conducted using morally sound approaches. To better understand the specifics of stem cell therapy for glioblastoma, data will be analysed utilising quantitative research that links thematic data analysis techniques.

## 3.7. Methodology limitations

Due to time constraints, this research is confined to secondary sources exclusively, which could diminish its efficacy. Mixed research with primary analysis will encourage readers to have opposing implementations, both in theory and in practice. Moreover, this study is limited to targeting specific business organisations and cannot organise an interview session with the business leaders to gain information related to costs and budgets of the inclusion of stem cell technologies in serious brain cancer glioblastoma. This will enhance the quality of the research and help readers to evaluate the information from industrial individuals. There are a few restrictions on the location zone that can be the target of this analysis in this study. Furthermore, several secondary studies on stem cell technologies have been conducted that have not only offered local information but also global information. These restrictions can be lifted by gathering more comprehensive data as a starting point and subsequently narrowing the focus to New York, USA, to connect the problem with wider-ranging issues. Therefore, a more thorough justification and analysis will aid in raising the quality of this post, however, it may take more time. A restricted research approach will narrow the concept and cannot make the discussion for different aspects as well. Besides this, the inclusion of primary investigation with interviews might help to make this discussion critical and motivate readers to wait till the findings. However, the strategic discussion will enable the optimisation of secondary data and uplift the strength of the findings.

## 3.8. Summary

Thus, to achieve the research objective and gather quantitative data on business difficulties related to the treatment of glioblastoma using stem cell therapy, this study is primarily motivated by positivist philosophy, deductive research methodology, and descriptive design. The results are obtained once the data analysis process has been completed. The findings are related to the study's goals and are used to determine the questions that will be investigated.

# CHAPTER 4: FINDINGS

## 4.1. Introduction

This chapter is discussed the selective articles through PRISMA which ensures data about stem cell therapies in glioblastoma. Through a data table, specific articles are enlisted and further discussion reflects the conclusions of the authors on this topic. Thus, diversification and critical observation are done in this chapter.

## 4.2. Findings

10 articles are selected and their outcomes are enlisted in a table which is attached in Appendix 1. The overall findings supported the stem cells that can be induced pluripotent or pluripotent to restrict the tumour formation in the brain as glioblastoma.

## 4.3. Discussion

As per Calinescu et al., (2021) among the cell types that produce exosomes most frequently are MSCs and NSCs. By delivering prodrugs, miRNAs, or tumour suppressors to glioma cells, exosomes from modified MSCs have been shown to effectively treat these cells in vivo and in vitro. Because it avoids hepatic and renal clearance and promotes greater exosome homing and dispersion, treatment utilising altered stem cells that produce exosomes in the tumour may be more effective. Finally, superior 3D platforms for testing the effectiveness of stem cell therapy for GBM are provided by in vitro brain tumour organoid models. According to Benmelouka et al. (2021), NSCs are the perfect source for continually generating glial cells and neurons to reconstruct neural networks in the damaged nervous system. Through cell replacement and migratory abilities, as well as the augmentation of nutritional and trophic supplementing effects through paracrine mechanisms, NSCs can speed up the recovery from brain injury. The systemically injected progenitor cells can penetrate the barrier and localise in glioblastoma foci, according to immunohistochemical studies that tracked NSCs' homing to glioblastoma in vivo. These models will probably be helpful for the urgently required detailed mechanistic investigations and for identifying the molecular players and pathways that coordinate the ideal and repeatable stem cell parameters. Combinatorial approaches utilising multimodal therapeutic stem cells will probably be more effective than the standard treatments. Combination therapy with various medicines capable of adaptability, as the tumour develops, is necessary for effective targeting of GBM. Miska and Lesniak, (2015) stated because the number of NSCs that can reach the glioma tissue depends heavily on their route of administration, the delivery method of NSCs is essential for effective therapy. Injection of NSCs in the opposite direction of the tumour site in mouse models of GBM results in their migration and effective treatment administration. Numerous techniques have been used to alter NSCs to produce anti-cancer effects. Researchers have found that the histone deacetylase inhibitor MS-275 and the cardiac glycoside lanatoside C can make glioblastoma cells more sensitive to the anti-tumour protein TRAIL (tumour necrosis factor-related apoptosis-inducing ligand). This has renewed interest in NSCs that express TRAIL.

Tamura and Toda, (2018) opined Neural stem cells (NSCs) can act as cellular carriers for cytokines, suicide genes, and oncolytic viruses and are capable of tumour trophic migration. Embryonic stem cells can be differentiated into NSCs. Yet the third potential cellular delivery technique is mesenchymal stem cells. Recently, induced pluripotent stem cells (iPSCs) were created. Due to their multipotency, iPSCs may be able to successfully differentiate into NSCs and perhaps resolve ethical and practical challenges in clinical application. The gene therapy approach proved appropriate for treating malignant gliomas, but viral vectors are insufficient to cover the extensive invasion area. The ability of stem cells to migrate has been anticipated. Some stem cell types have lately been developed. Nevertheless, a comparison of the strongest stem cell types shows migration ability and the tumoricidal effect is needed. This process is a better approach towards innovative glioblastoma care but there are complications in iPSCs due to the huge cost of isolation. On the contrary, the process of transforming pluripotent to iPSC takes a long time which will reduce the efficiency of glioblastoma care. Huang et al., (2019) opined iPSC line can be created and validated for US $10,000–$25,000. From patient recruiting to final characterization, the complete procedure takes between 6 and 9 months. It takes an additional 3 to 6 months to manufacture substantial quantities of iPSC derivatives. The importance that iPSCs play in regenerative medicine will be highlighted by further development in the field. Many researchers continue to face obstacles because of the expense and length of time involved in the creation of iPSCs. Thus, this approach is one of the costliest treatment processes for glioblastoma with high efficiency.

Li et al., (2014) stated Preclinical research into stem cell treatments for brain tumours is ongoing, but clinical trials have revealed little promise. A hurdle to achieving consistent efficacy, according to our analysis of the literature, is the use of artificial matrices to create heterogeneous stem cell populations. They provide an ETG as a standard platform to instruct stem cells to attack cancer cells, resolving the inconsistent results of present clinical trials. Future stem cell production should be structurally and functionally characterised before being used for transplantation utilising a quality control system.

The study by Chen et al. (2022) demonstrates that it is possible to genetically modify the macrophages and microglia that surround the glioma resection cavity so that they express GSC-specific CAR macrophage cells with the NP-hydrogel superstructure and can eliminate any CD133+ GSCs that are still present to prevent the development of GBM and therapy resistance. Therefore, their research merits additional clinical validation since it may offer patients with recurring cancers a more effective immunotherapeutic strategy. This avoided postoperative glioblastoma relapse and produced a robust tumoricidal immunity encircling the postsurgical cavity. As a result, our work proposes a locoregional therapy strategy for activating tumoricidal immunity specific to cancer stem cells in individuals with recurring malignancies.

Biserova et al., (2021) found the most typical malignant brain tumour is glioblastoma. It is distinguished by a grim prognosis and a small but rising occurrence. Radiation, contemporaneous or adjuvant chemotherapy with temozolomide, and surgical resection are the best treatments for glioblastoma. With the best treatment, however, a median survival time of 14 to 21 months is possible. Recurrences are common and practically inevitable. A key component in the aetiology of treatment resistance and recurrences is the expression of CD133 and nesting by glioma stem cells. Two theories have been put out regarding the origin of GSCs. Polat et al., (2022) supported the experiment and stated Known also as prominin-1, the membrane-bound glycoprotein CD133 is a marker for human neural stem cells. It appears to be crucial for tumour invasion and recurrence as a CSC cell surface marker. The radio resistance that causes recurrence, increased malignancy, and poor survival is strongly correlated with a rise in CD133 expression. Experimental evidence of malignant changes in neural stem cells suggests that replication stress may facilitate these changes. It is also possible for non-stem glioblastoma cells to dedifferentiate and achieve a dynamic equilibrium with GSCs.

Matarredona and Pastor propose that GBMs might develop from NSCs located in the lining of the lateral ventricles that undergo malignant transformation because of the similarities between NSCs of the SVZ and GSCs. Recent studies have shown that astrocyte-like NSCs of the adult human SVZ have driver gene alterations that enable them to evade niche control, resulting in unchecked proliferation and malignancy, supporting this notion. Low-level driver mutations in the TERT promoter or cancer-causing genes including PTEN, TP53, and EGFR have been found in the malignancies of GBM patients as well as in tumour-free SVZ tissue.

The results of Zhao et al. (2021) suggest that AR antagonists may be used to treat GBM. Despite being well tolerated, enzalutamide demonstrated excellent efficacy in the syngeneic orthotopic mouse GBM model; nonetheless, only 50% of the animals survived over the long term. A new therapeutic target for GBM may be suggested by AR's suppression of cancer stem cells in gliomagenesis, which appears to be a key facilitator of possible pharmacological effects. Weight gain, a common side effect of androgen deprivation therapy, was seen to be much more pronounced in the drug-treated mice. On the other hand, the expensive, time-consuming, and ineffective models employed to investigate the disease are contributing factors in the high failure rate of treatment development for this cancer. However, despite the encouraging developments in stem cell and in vitro culture technologies, in this article, we outline the benefits and drawbacks of the various organotypic culture models and explain how they might be used to research glioblastoma. According to estimates, each medicine costs between $1 to 1.3 billion, and the entire procedure for biologicals takes about 8 years. Small molecules take about 12 years to produce, while more current cost estimates range from $2.4 billion and above (Pamies et al., 2020). Comparatively to a median of 90% for all therapeutic categories, around 95% of putative anticancer medicines that enter clinical development fail. Only a 3.4% overall success rate in clinical trials was discovered in recent evaluations. The lack of a relationship between traditional in vitro models of human disease and animal models suggests that human pathophysiology is studied using inferior models, which contributes to the high failure rate in drug development.

In conclusion, the research of Bomba et al. (2021) demonstrates the viability of autologous iNSC generation and the low toxicity profile of these cells. Additionally, they offer two delivery methods that can be applied in clinical settings. These results pave the way for prospective human clinical trials and demonstrate the value of performing more thorough big animal efficacy studies. Plummer et al.'s (2019) statement that more accurate human physiological systems for drug testing may be made possible by models made from human induced pluripotent stem cells (iPSCs) and novel elementary human cell culture techniques like 3D culture, microfluidics, and microfabrication. It can be difficult to use "Human on a Chip" systems with high throughput applications that combine many organotypic models with microfluidic perfusion. Spheroid models made from primary human tissues provide a solution in this regard because they can be manufactured in huge quantities and with great homogeneity, enabling the application of drug testing at an earlier stage of preclinical research.

Satterlee et al. (2019) suggest novel hybrid models that effectively capture critical features of GBM heterogeneity that significantly impact treatment response to demonstrate how tNSC mono- and combination therapy may navigate some parts of heterogeneity for effective tumour elimination. To sum up, researchers have created a novel hybrid GBM tumour modelling approach that can be produced from both patient biopsies and tumour cell lines, recapitulating important elements of growth and medication response. In the first application of this novel methodology, they have discovered unexpected advantages and disadvantages of two key tNSC therapeutic pathways that serve as a foundation for future medication optimisation, including crucial preclinical research for combination tNSC therapies. This approach lays the groundwork for creating increasingly complex hybrid medicines when therapies are improved.

As per Fares et al., (2021) Particularly in patients with MGMT unmethylated tumours, NSC-CRAd-S-pk7 induced an immune-mediated anti-glioma activity and demonstrated encouraging survival results. Exploratory immunological data are in favour of continuing research on NSC-CRAd-S-pk7 with repeated intracranial catheter injections and/or its pairing with anti-PD-1 immunotherapy in a higher phase trial including a bigger patient population. In conclusion, the experiment has demonstrated that NSC-CRAd-S-pk7 injection during surgery in patients with recently diagnosed malignant gliomas is generally safe and tolerable. In this trial, it was possible to start regular chemo-radiotherapy right away without experiencing significant delays or difficulties. Positive clinical results are predicted by the treatment, particularly for patients with MGMT unmethylated gliomas.

## 4.4. Summary

This chapter concludes on the effectiveness of the studies and their observational approach. The clinical trial on mice for glioblastoma suggests there is a positive impact of stem cell therapy in glioblastoma care.

# CHAPTER 5: ANALYSIS & CONCLUSIONS

## 5.1. Introduction

This chapter concludes the dissertation with its limitations and scope for improvement. Through critical discussion on the LR and findings, the analysis part highlights the outcome of the innovative medical care approach with its business pattern. Initially, the conclusion describes the methodological approach with its effectiveness for this research. The pattern of data collection and its quality assessment is critically analysed in this part. At the end of the chapter personal reflection is described about the learning and developmental opportunities. This will connect the future aspects of personal learning and self-development as well.

## 5.2. Critique of Adopted Approach

According to positive research philosophy, opinions or theories that cannot be verified by firsthand experience or direct observation do not represent actual knowledge. Research on a range of topics, such as glioblastoma and stem cell therapy, the nature of interpretation, and the reader's place in society, was conducted using it. The positivist school of thinking was taken into consideration when choosing the study's aims (Marsonet, 2019). Researchers were able to evaluate the effects of the glioblastoma stem cell treatment by using the positivist mentality. The study was created using deductive research methods. The theoretical framework that was used to analyse the study's aims was brought into focus through the deductive method. On the plus side, this investigation employed the deductive research methodology. The methodological approach used to investigate asset management theories and the outcomes of stem cell treatment for glioblastoma will also be determined.

The interpretivism philosophy was applied to gather useful data for this investigation but failed to conduct this for data collection. The subjective character of interpretivism and the considerable likelihood of researcher bias have been identified as key drawbacks. The essential data acquired during interpretivism studies could not be generalised since the participants' beliefs and values had a significant impact on the outcomes. Limited resources for situating the methodology, difficulties using a methodology that was less well-known, and ambiguity about the level of interpretation to pursue are further problems. Hence, it was not effective to implement an interpretivism philosophy for collecting data regarding stem cell technologies in glioblastoma care.

Despite using an inductive research approach, this study focused on the deductive one as it was beneficial to gather and analyse data from broader aspects. The biggest flaw in the inductive approach was that nothing can be proven by utilising inductive methods. Data can only support, contradict, or infrequently disprove a generalisation. Inductive reasoning begins with a single example before making an often-unsuccessful attempt to generalise. Inductive reasoning's fundamental flaw was its lack of completion, which can lead researchers to draw incorrect conclusions even from precise data. On the contrary, the deductive approach Starts with a theory, creating a hypothesis based on that theory, and gathering and analysing facts to test those hypotheses. To better understand the subject being studied, researchers may combine inductive and deductive research methods.

Additionally, the descriptive research approach makes the study's findings better and is more applicable. When conducting study on a subject, descriptive research is beneficial. In comparison to other study techniques, it may lead to a deeper comprehension of the subject. Descriptive research does have some restrictions, though. Descriptive research has the drawback of being unable to produce conclusions that can be broadly applied. Secondary research methods were chosen over primary research methods since they need less time and money. While doing primary research, secondary research can be finished quickly. For the dissertation, only respectable journals were consulted. To obtain information, books were used. The study was conducted, though, in a morally honourable manner. Electoral statistics, books, journals, medical records, and other print media were sources of secondary quantitative data. These resources allow for the collection of real data, which can then be evaluated via a literature review. All the information was gathered from open-access sources, including reputable, academic institutions' approved news, research, and statistics websites.

Different research designs were implied in this study. The main limitation of a correlational study was that it can only show correlations between exposure and outcomes. The existence or influence of factors other than the two under investigation cannot be investigated by correlation. It is critical to keep in mind that correlation does not equate to causation. Curved relationships could not be explained by correlation alone. Exploratory research has limitations, including the confusing data it provides, the lack of structured methodology it employs, the small sample size it uses, and the use of outdated information that could jeopardise the accuracy of the results. The exploratory study examines open-ended issues from earlier studies. The fundamental conclusions typically serve as the starting point for additional research. However, the descriptive one applies to this study due to its positive connections. It gives the researcher the ability to look at and analyse the distribution of one or more variables without considering any causal or other hypotheses. Through descriptive research, any topic we wished to check the data, thoroughly examined, and the amount of knowledge. This is particularly true with descriptive studies with qualitative data.

For quality secondary data collection PRISMA framework was used as it helps to sort the articles based on inclusion criteria which enhances the quality of the study. It was focused on detailed analysis rather than specifying articles that will not provide in-depth justification for this topic. However, in future working with primary data, it will be beneficial to implement interpretivism philosophy along with experimental research design. These methods will help to interpret the collected primary data that can be through surveys and interviews which will enhance the quality of the study. Target audience-based analysis will help in business market understanding and focus on the customer requirement rather than investing more in R&D. On the other hand, I will not follow the inductive approach as it takes a narrow topic to a broader one but for specification deductive approach is one of the most useful and valuable information. Moreover, I will follow the mixed research method if there is an effective time for the completion of the project. The mixed research method helps the study to make more critical and creates a strong connection between secondary data and practical experiences.

## 5.3. Analysis

Special medications are given to chemotherapy patients that are intended to kill tumour cells. The standard of care for GBM now is chemotherapy with the medication temozolomide. The most severe form of brain cancer, glioblastoma, is thought to be progressed at the time of diagnosis. As of right now, there is no technique to destroy cancer cells. In the United States, the projected total direct medical expenses for surgery and radiation therapy per patient ranged from $50,600 to $92,700 before the approval of effective chemotherapeutic medicines for malignant gliomas. Compared to comparatively inexpensive maintenance treatment ($14,490.53), recurrence care cost $52,125.77 in total (Liu et al., 2019). The delivery approach in stem cell-based therapy for GBM must be carefully considered to ensure that enough cells can reach the tumour and offer therapeutic advantages. Additionally, it has been shown that intraventricular injection results in an effective intratumorally dispersion of stem cells. Quantitative investigations and three-dimensional (3D) reconstructions of NSC dispersion in mice following intraventricular injection by Calinescu et al. (2021) revealed that these cells travelled swiftly in the direction of tumours even when the lesions were multifocal and distributed across hemispheres. To circumvent the blood-brain barrier's (BBB) restrictions on the mobility and authorisation of therapeutic cells following systemic injection, this approach can transfer therapeutic cells via the perivascular pathway across the central nervous system (CNS) to the olfactory or trigeminal nerves. These details were discussed in LR part 2.2 which is effective information regarding NSCs and their implications in glioblastoma care.

Moreover, in Chapter 4 findings, the discussion of Tamura and Toda (2018) describes, neural stem cells (NSCs) can migrate tropically towards tumours and serve as cellular transporters for cytokines, suicide genes, and oncolytic viruses. Induced pluripotent stem cells (iPSCs) were developed recently. Due to their multipotency, iPSCs might successfully differentiate into NSCs, potentially resolving moral and practical issues in clinical application. On the other hand, the lengthy process of turning pluripotent cells into iPSCs will decrease the effectiveness of glioblastoma treatment. According to Huang et al. (2019), iPSC lines can be produced and validated costing between $10,000 and USD 25,000. The entire process takes between 6 and 9 months, from patient recruitment to final characterization. Making significant amounts of iPSC derivatives requires extra three to six months. Thus, NSC and iPSCs are important factors of stem cells that reduce graft rejection issues. However, the processing cost is high and takes a long time to produce the iPSCs.

Thus, the main business management issue for GBM care through stem cells involves cost management, time management and ethical/ performance pressure. This reduced the operational quality of a business operating team who provides innovative service to GB patients. Reduction of customer acceptance due to a long time and huge budget will hamper the business chain of the organisation (Nowak et al., 2021; Tu et al., 2020). Moreover, ethical glitches with technological complications might reduce the interest in accepting modern care options. On the other hand, the first research objective of understanding contemporary theories with their challenges is discussed in these 2 sections in detail. Both are stating that research limitations and long-term process creates business challenges for stem cell development technologies for Glioblastoma in New York, US. Hence, the objective was met with proper evidence.

Glioblastoma management is intricate and multi-layered. The selling of anticancer medications and therapies is the primary source of income for glioblastoma businesses. As medical technology develops, these businesses must also provide novel cures and treatments, and they frequently collaborate with other organisations dedicated to cancer research (AANS, 2023). LR part 2.2 described the market for adult malignant glioma treatments is anticipated to expand at over 2%. Due to advantageous government and regulatory policies that support the development of imaging technology developments that enables early disease diagnosis and beneficial Policies governing glioma product reimbursement around the world, the market is anticipated to grow over the projected period (Stylli, 2020).

As per LR part 2.3, imaging during glioblastoma therapy often costs between $2,788 and $3,719 on average. In investigations, various therapeutic modalities were combined. The utilisation of the modern treatment approach brought about an average cost of $62,602 and 16.3 months of survival in studies by Goel et al., (2021). The patient or family must pay indirect expenditures, which are expenses unrelated to the therapy or medical care. Other authors have tried to compute the indirect costs of GBM while accounting for sickness, early retirement, and death. The total yearly indirect expenses for the Swedish population were estimated by Cagney and Alexander (2017) to be $22.5 million per million. For patients under 65, the indirect costs were dominated by a mortality rate of 73.1%. The high expense of crucial brain cancer treatment prevents patients from making significant financial investments for a better quality of life. Huge expense is not affordable for most individuals throughout the world as most of them are falls under middle-income countries. Cost management is the process of organising and regulating a company's operating costs. To plan, predict, and monitor expenses also requires gathering, analysing, and reporting cost data more accurately.

Typically, surgery, radiation treatment, and chemotherapy are used to treat GBM. There are few therapy options for GBM, and new ones are always being developed. The market for GBM treatments is huge and expanding quickly. According to LR part 2.4, by 2021, the market should have grown from $2.2 billion in 2016 (Research and Markets, 2023). The GBM therapy market includes a variety of medical items and technology that are useful for treating patients with glioblastoma. Although it is difficult to determine the market size for GBM treatments, several studies indicate that it may exceed $3 billion by 2025. If a good cost management system is in place, an organisation can more simply estimate and distribute its budget. Cost management, a part of management accounting, helps a company lessen the possibility that future spending will go over its budget by making more precise estimates of such costs. In this research of stem cell-based treatment the research and development costs are higher than usual which directly affects the business expenses and due to high cost, the number of customers will also be lower than other operations as mentioned in the Literature review section as well (Jiang et al., 2014; Allsopp et al., 2019). Hence, it will directly hamper the business growth and the marketisation plan of GBM care through stem cell implementation.

According to Zhao et al.'s (2021) findings, GBM may be treated with AR antagonists. Enzalutamide had great efficacy in the syngeneic orthotopic mouse GBM model despite being well tolerated; nonetheless, only 50% of the animals survived over the long term. On the other hand, the high failure rate of this cancer treatment development is a result of the costly, time-consuming, and inadequate models used to study the disease. Each medication costs between $1 and 1.3 billion, and the complete process for biologicals takes roughly 8 years, according to estimates. While more recent cost estimates range from $2.4 billion and upwards (Pamies et al., 2020), small molecules require around 12 years to develop. Comparatively, 95% of potential anticancer drugs that enter clinical development fail, compared to a median of 90% for all therapeutic categories. Recent analyses only found a 3.4% overall success rate for clinical trials. Human pathophysiology may be researched using subpar models because there is little correlation between conventional in vitro models of human disease and animal models, which explains the high failure rate in drug development. Thus, both LR and findings are stating the high efficiency of stem cell therapy in glioblastoma with a higher survival rate. The average cost is higher than chemotherapy and radiation therapy which reduces customer acceptance.

To show how tNSC mono- and combination therapy may navigate some aspects of heterogeneity for efficient tumour eradication, Satterlee et al. (2019) propose innovative hybrid models that effectively capture essential features of GBM heterogeneity that significantly impact treatment response. In conclusion, scientists have developed a novel hybrid strategy to mimic GBM tumours that can be generated from both patient biopsies and cancer cell lines, recapitulating key aspects of growth and treatment response (Levy et al., 2020). They have identified unanticipated benefits and drawbacks of two important tNSC therapeutic pathways in the first use of this unique methodology, laying the groundwork for future drug optimisation, including vital preclinical research for combination tNSC therapies. This strategy offers the framework for developing hybrid drugs that are more sophisticated as therapies advance.

## 5.4. Overall Conclusions

Surgery is the initial step in treating GBM, and then chemotherapy and radiation therapy are used. The main goal of surgery is to remove the tumour entirely while safeguarding the healthy brain tissue that surrounds it which is crucial for the best possible neurological function. Therapeutic drugs for the treatment of glioblastoma have been created over the past 20 years employing neural stem cells (NSCs), mesenchymal stem cells (MSCs), and produced NSCs (Tamura and Toda, 2018). GBM is now incurable due to the high risk of recurrence following standard multimodality therapy, which entails surgery to remove the primary tumour, radiation treatment given concurrently, and adjuvant TMZ chemotherapy given to eradicate any cancer cells still present. As glioblastoma grows, it spreads into the nearby brain (Grand view research, 2023). Because of this, complete tumour eradication via surgery is difficult. Radiation and chemotherapy can penetrate tumours, but glioblastoma cells can endure and grow again. This chapter assesses the funding for US glioblastoma research and its projected expansion over the next few years. Thus, it can be concluded that GBM treatment requires more research and development with huge funding (Polaris market research, 2023). The study of diverse non-pharmacological treatments for cancer care involves different steps and it is a costly process. Government investment and support are important to marketize the care plan for GBM (CIRM, 2022). The governing and non-governing authorities are funding this study to develop medicine and improve the treatment process using non-pharmacological methods.

The effectiveness of stem cell therapy might vary depending on the type of treatment, the illness or condition being treated, and the stage of the illness. For a variety of disorders, stem cell therapy is largely recognised as a safe and effective treatment option, and multiple clinical trials have produced positive outcomes. A stem cell therapy may cost between $5,000 and $50,000 USD. The price of treatment might vary widely depending on a wide range of factors. The type of stem cells used can affect how much a stem cell therapy will cost. The availability of stem cells and ongoing research both have an impact on their cost. Since stem cell research is currently underway and treatments need highly specialised procedures, most insurance companies and the government have not yet adopted them (Huang et al., 2019). Since using iPSCs does not raise any ethical issues, it has several advantages over using embryonic stem cells. In culture, iPSCs can self-renew and develop into any cell type from all three germ layers (ectoderm, mesoderm, and endoderm). Furthermore, the advancement of iPSC technology makes it possible to produce an essentially infinite number of human pluripotent stem cells that are either disease-specific or healthy. The 'gold standard' for disease modelling is the use of primary, patient-derived disease-affected cell types, however obtaining such cells is a significant challenge. The ability of iPSCs to self-renew in culture enables broad research using donor-derived, healthy, and sick cell lines. The ability to study human illness characteristics that are now challenging to achieve in animal models has been made possible by the generation of numerous sick iPSC lines, making iPSCs an appealing choice. The present ethical concerns concerning stem cell-based therapies are centred on the iPSCs' infinite potential for differentiation, which bears the risk of creating human embryos and human-animal chimaeras and can be used for human cloning (Huang et al., 2019). Future obstacles include perfecting the therapeutic use of stem cells, verifying these technologies in randomised clinical trials, and controlling the spread of regenerative medicine around the world. Due to their multipotency, iPSCs might successfully differentiate into NSCs, potentially resolving moral and practical issues in clinical application. Malignant gliomas responded well to gene therapy, although the vast invasion area cannot be sufficiently covered by viral vectors.

On the other hand, the lengthy process of turning pluripotent cells into iPSCs will decrease the effectiveness of glioblastoma treatment. The expense and time required to create iPSCs continue to present challenges for many researchers. As a result, this strategy is one of the most expensive yet very effective glioblastoma treatment methods. To accurately reproduce key aspects of growth and treatment response, the researchers have developed a novel hybrid GBM tumour modelling approach that can be generated from both patient biopsies and cancer cell lines (Satterlee et al., 2019). They have identified unanticipated benefits and drawbacks of two important tNSC therapeutic pathways in the first use of this unique methodology, laying the groundwork for future drug optimisation, including vital preliminary studies for combined tNSC therapies. Because iPSC-derived neurons have identical genetic material, cell shape, and neuronal connections to those present in the human brain, they offer attractive alternatives to animal models for investigating neurological diseases and brain tumours. Major neurological illnesses now have pathological models that can be utilised to clarify pathogenic pathways and assess medications in preclinical settings. But using iPSCs to simulate brain tumours is still a difficult and uncharted field of study. iPSC-derived human brain tumour platforms have slowly started to appear over the past ten years as a result of recent advancements in techniques for collecting tumorigenic mutations and organoid creation.

To create brain microvascular endothelial cells (BMECs) from iPSCs, Lippmann et al. pioneered the process of endothelial and neural codifferentiation of iPSCs in an unconditioned medium, cell multiplication in an endothelial cell medium, and selective matrix-aided cell purification. By coculturing these iPSC-derived BMECs (iBMECs) with astrocytes, the team was able to induce the expression of endothelial transporters and receptors in addition to the restoration of BBB features like properly-organized tight junctions and polarised efflux transporter activity. The effective techniques led to improved iPSC seeding densities, quicker differentiation, precise developing timing, streamlined defined medium, higher iBMEC purity, and cryopreservation capability. The creation of a homogenous epithelial cell population is primarily one of the remaining iBMEC procedures' shortcomings.

Physical and cognitive capacities may be impacted by glioblastoma. These abilities can be enhanced by cognitive and physical treatment, which can also assist patients in more effectively navigating the difficulties of their illness. In addition to all these non-pharmacological remedies, stem-based healthcare is another approach that is being studied (Zhao et al., 2021). Due to societal and environmental problems, this market size is growing, but effective treatment will improve medical services. However, it can be easily concluded that social development and customer awareness are important aspects of this care program (Curry, 2021). Social and medical ethics restrict social acceptance and result in business management failure as well. Thus, ethical considerations for iPSCs are needed to be taken for more critical research and public service. In terms of business growth, ethics and consent form takes serious concern which ensures trust and customer attention as well (Prager et al., 2020). Based on the condition of glioblastoma, patients and their peers are informed of different treatment plans. However, if the condition is more serious patients need to provide consent to apply costly stem cell therapy which ensures the feasibility of the patient's family as well. Hence, the scope of social or medical disruption gets lower in this case.

Managing different steps of stem cell derivation requires huge monetary support and cost management. Another conclusion states segregation of budget plans based on the priority of business operations is effective for managing internal stability. As it is providing medical service, inventory management along with research are more important aspects (AANS, 2023). In terms of patient care viable cell lines are used and those are preserved through cryopreservation which is a costly process. Thus, budgeting and prioritizing the sections will reduce the complications in medical care business operations.

## 5.5. Limitations of The Study

This page just refers to individual research studies without relating them to other elements like work problems, discrimination problems, and childhood stress. This evaluation of the worldwide difficulties did not focus on any one age group. The governing body will be able to change its policies to lessen the global burden of mental health crises with the aid of target age group-based analyses. Additionally, this article followed a systematic review instead of a primary analysis, which would have provided a more accurate portrayal of the social data, due to time constraints. On the other hand, it is not feasible to actively collect public data globally. As a result, these restrictions affect how this research site operates.

## 5.6. Opportunities for Further Research

The new technique makes use of bio-adhesive nanoparticles that adhere to the cancer site and gradually release the synthesised peptide nucleic acids they are carrying. These peptide nucleic acids particularly target the small RNA strands called microRNAs, which regulate gene expression. This approach can be included in stem cell-based therapy for its target-based care process. However, the cost will be getting higher than usual as it includes 2 costly processes for glioblastoma care. Brain tumours can be effectively treated using stem cell-based gene therapies for glioblastoma, according to studies. The effects of bone morphogenetic protein (BMP4) on glioma cancer stem cells are also investigated. Many cell-based cancer therapies come from the immunological or stem cells of the patient. However, due to the rapid course of a disease like GBM, most patients have surgery within a week of being diagnosed, leaving little time for the development of therapies. Because of this, surgical removal of all tumours was challenging. Tumours can be penetrated by radiation and chemotherapy, but glioblastoma cells can resist and continue to develop.

The therapeutic manipulation of stem cells will need to be improved, these technologies will need to be validated in randomised clinical trials, and there will be regulations to control the spread of regenerative stem cell therapies globally. This discovery sets the groundwork for the construction of an engineered therapeutic stem cell biobank that will one day be used to treat a variety of challenging-to-treat malignancies, including GBM, by targeting various receptors on tumour cells and immune cells in the tumour microenvironment. Moreover, there is immense research needed for evaluating the treatment cost as it is the main concern to provide better medical service to society. Innovation and medical research will help to get the opportunity but if the service is not pocket friendly and feasible it will be tough to reduce the number of death cases due to glioblastoma. As responsible individuals, we need to integrate the cost and quality of service for a better world. Governing bodies need to invest in this approach to meeting and influencing patients to have this therapy which has a smaller number of rejections than other treatment processes. Hence, there is a scope for research for innovating a budget-friendly stem cell-based glioblastoma care.

## 5.7. Reflection

In this section, I will be sharing my learnings and their future scope for my career development. Through this research, I need to gather theoretical perspectives on stem cell therapy and the complications of glioblastoma. This enhances my research ability for a medical issue and focuses on the patient service approach. To understand the market demand and its need for uplifting the medical facility in society, the detailed discussion helped me a lot. Research is contextualised, made understandable, and justified by theory. Theory aids in outcome prediction and identifies uncharted territory or potential research opportunities. The likelihood that qualities, variables, or data are related is diminished by the absence of a theory. Theory is a tool that aids in problem identification and the generation of solutions. While conducting the detailed literature review, I need to focus on the budget issues and time as well.

Personally, conducting secondary qualitative research by selecting specific articles is a hugely time-consuming process. This study helped me to design a time frame and manage my work along with this dissertation. Without a good time, management plan, I will not be able to complete it effectively. Good time management increases research production by letting researchers focus on their duties. Because of this, creating and maintaining a good research plan requires having excellent time management abilities. Productivity gains, stress reduction, and greater opportunities to reach significant objectives are just a few of the many advantages of efficient time management. Through Mind Tools, you can get access to a variety of tools to enhance your time management abilities. The time management techniques used by university instructors and students can be studied qualitatively to determine the realities pertinent to those techniques. Since it directly affects the quality, scope, and cost of a project, project time management is one of the most crucial knowledge areas in project management. The timely and cost-effective completion of projects is ensured by effective time management.

Furthermore, if a good cost management system is in place, as identified in this study, an organisation may more simply predict and distribute its budget. Cost management, a part of management accounting, helps a company lessen the possibility that future spending will go over its budget by making more precise estimates of such costs. The process of calculating, allocating, and controlling project costs is known as cost management. A company can reduce the possibility of budget overruns by using the cost management technique to budget for future expenses. Cost estimates are created while the project is still in the planning stages and must be accepted before construction can begin. Resource planning is one of the most important aspects of cost management. It is critical to have a comprehensive understanding of the resources required and their associated expenses to manage costs. Governing authorities need to provide utmost support to research in the medical field which involves stem cell therapies.

I felt improvised while conducting this study, however, I feel some restrictions as well. In terms of secondary qualitative, we cannot proceed with interviews which is one of the great pieces of evidence for our research. I might conduct a mixed research method which gathers primary data from patients and justify them with secondary information. The restrictions observed from the operational failures and limiting the data collection process due to cost and time.

On the other hand, being a management student, we need to understand the value of time, money and social responsibilities which will be denoted as integrated management with psychogeography. Customer affordability and target audience need to be fixed before demanding the high cost of the services. As identified in this study, prolonged medical processes with huge costs restrict most patients to accept the innovative and globally accepted medical system over radiotherapy.

There are diverse things which I had learnt and made a note for further development as well. I need to be more focused on the profitability of this medical service rather than lowering the service cost. Patient care and service costs are the main factors but without calculating the profitability it is tough to run a business as well. Medical service cannot be limited to minimal as it takes high security and quality service thus, the cost gets higher. However, if there is a smaller number of customers it will be tragic to continue with the business. Thus, I planned to work on myself by listing the prioritised actions rather than giving all the impotence to a single task.

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# Appendices

## Appendix 1: Article details

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Author** | **Year** | **Country** | **Type** | **Number of participants** | **Outcome** |
| Calinescu et al., | 2021 | Not mentioned | Review article | 0 | Extensive and persistent efforts are being made to create efficient immunotherapy methods for GBM, motivated by results in the treatment of other solid tumours with immune checkpoint inhibitors. |
| Tamura and Toda | 2018 | Not mentioned | Review article | 0 | Embryonic stem cells can be differentiated into NSCs. Mesenchymal stem cells are yet another potential cellular delivery system. Induced pluripotent stem cells (iPSCs) have recently been developed. This paper reviews recent developments in malignant glioma stem cell treatment. |
| Li et al., | 2014 | Not mentioned | Review article | 0 | Preclinical research into stem cell treatments for brain tumours is ongoing, but clinical trials have revealed little promise. A hurdle to achieving consistent efficacy, according to their analysis of the literature, is the use of artificial matrices to create heterogeneous stem cell populations. |
| Chen et al. | 2022 |  | Review article |  | The combination of treatment with nano porter-hydrogel framework and CD47 antibody increased the proportion of positive immune replying cells and crushed the negative immune regulating cells in an orthotopic patient-derived glioblastoma humanised mouse model. |
| Biserova et al., | 2021 | Not mentioned | Review article | 0 | Future therapies that target GSCs are discussed along with the part GSCs play in glioblastoma treatment resistance. Thus, glioblastoma stem cells serve as both a catalyst for significant treatment challenges and a potential focus of more successful future strategies. |
| Matarredona and Pastor | 2019 | Not mentioned | Review article | 0 | The idea that GBMs might originate from NSCs living in the lining of the lateral ventricles that experience malignant transformation is based on similarities between NSCs of the SVZ and GSCs. |
| Zhao et al. | 2021 | Not mentioned | Review article | 0 | Pre-clinical findings from Werner et al. in the flank implant tumour model suggest that additional dose escalation studies for GBM patients or combining this drug with other common treatment options for GBM, such as temozolomide and/or radiation therapy, may be required to further enhance the outcome. |
| Bomba et al. | 2021 | North Carolina | Primary analysis | – | Researchers were also able to prove the safety of iNSCs using the canine model by performing neurological tests, fluid screenings, and histological examinations. Anomalies in canine posture, movement, and vision resembled potential side effects of human brain surgery. Additionally, blood, urine, and CSF tests showed that iNSCs did not provide any alarming safety signals, regardless of the administration of the FLOSEAL scaffold or the ICV reservoir. Although the transitory neutropenia and reproductive toxicity results were unexpected, they may be related to the prodrug VGCV injection rather than the iNSCs. |
| Satterlee et al. | 2019 | Not mentioned | Primary analysis | 10 | Optical imaging, genomic testing, and immunohistochemistry revealed that the hybrid models accurately captured a number of important characteristics of the patient's GBM, including heterogeneity in TRAIL sensitivity, cancer stem cell populations, proliferation, hypoxia, migration patterns, blood vessel structure, and immune infiltration. Testing in various in vivo models revealed that tNSC-TRAIL therapy considerably improved survival across all paradigms and potently suppressed tumour growth, allowing researchers to examine the effects of heterogeneity on tNSC therapy. The manner of delivery, dose, and kind of therapy (tNSC-TRAIL or/and tNSC-thymidine kinase) all had an impact on the patterns of cancer recurrence. |
| Fares et al. | 2021 | Not mentioned | Primary analysis | 36 | This study has established the relatively high safety and tolerability of NSC-CRAd-S-pk7 injection during surgery in patients with recently diagnosed malignant gliomas. In this trial, it was possible to start regular chemo-radiotherapy right away without experiencing significant delays or difficulties. Positive clinical results are predicted by the treatment, particularly for patients with MGMT unmethylated gliomas. |

## Appendix 2: Ethics approval form

**Research Ethics Application for Taught Degree (Bachelors & Masters) students**

Application for study involving Human Participants

***NB: This form should be submitted to your research project module leader once reviewed, discussed and signed by your research supervisor. The form is designed as a discussion document as well as a record of ethical approval. Please ensure you have carried out a*** [***Privacy Impact Assessment***](https://www.cumbria.ac.uk/media/university-of-cumbria-website/content-assets/public/researchoffice/documents/PrivacyImpactAssessment.docx) ***if your project involves collection of personal data.***

**All fields will expand as required.**

|  |
| --- |
| 1. Title of Project:  **Business challenges of Stem Cell Technologies for Glioblastoma in New York, US** |
| 2. As this a student project, please indicate type of course you are on by ticking/ highlighting the relevant box:  □ BSc □ BA □ MSc □ MA □ MBA □ PgC □ PgD |
| 3. Type of study: please indicate type of study you are on by ticking/ highlighting the relevant box:  □ Involves direct involvement by human subjects     * Involves existing documents/anonymised data only. |

|  |
| --- |
| 4. Name of applicant (the student): |
| 5. Your project supervisor(s)  Name(s):  E-mail(s): |

|  |
| --- |
| 6. Provide a concise **summary of your research project in lay terms** (maximum length 150 words). What are you planning to do?  This project is based on development of Stem cell technologies for Glioblastoma in US which provides description about importance of stem cell technologies and its impact on healthcare system. Moreover, there are different factors to generate a stem cell line such as cytokines, micro-RNAs, chemokines, and exosomes. Furthermore, examined are the effects of transforming bone morphogenetic protein (BMP4) on glioma cancer stem cells. In vitro CD133-positive cell proliferation is efficiently inhibited by BMP4, as is in vivo tumour development. Detailed description shows thee statistical information of stem cell technologies and investments for stem cell research as well. This is newly emerging part which need to be implemented in the healthcare section to uplift the deadly issues such as cancer. On the supportive note through secondary data collection process different articles are shortlisted regarding stem cell technologies in US and globally. Through the detailed qualitative analysis, the importance of stem cell technology will be derived and solved the helathcare complications easily. |
| 7. Describe the **sample of participants** (including for example, number, age, gender).  Participants are not present in this secondary analysis however, it includes specific criteria such as key words, publishing year and research paper language. The publishing year was only specific to last 6years and the paper must be written in English. Moreover, they need to be open accessed. |
| 8. Explain concisely how you will **recruit the participants** (be specific).  Using specific key words articles are shortlisted and by checking the in-depth quality of the research articles are gathered for secondary qualitative study. Key words are stem cell research, stem cell technology, stem cell in healthcare, stem cell used for patientcare in USA, stem cell technique worldwide. |
| 9. Explain concisely how you **obtain informed consent from participants**. You need to ensure it is easy for people to withdraw consent and tell them how.  As this is focused for secondary analysis, full length articles are only shortlisted from databases. Open access articles do not require consent but need to maintain proper referencing which will be done properly. |
| 10. Explain how you will **maintain data protection**. State what personal and/ or sensitive data you may collect and how this will be stored (see guidance [UK General Data Protection Regulations (GDPR](https://ico.org.uk/for-organisations/guide-to-the-general-data-protection-regulation-gdpr/key-definitions/))).  Different statistical data will be included for qualitative analysis and solve the complications detected in research aim. As per the UK data protection regulations the statistical information is gathered and properly analysed and most of the data are collected from government websites. |
| 11. Explain concisely how you will offer **review opportunities**, a debrief or, follow up for participants (as appropriate).  There is high scope of further review with the collected data. For doing systematic review this article will provide qualitative information that enhance quality of an article. Moreover, this article can be used for academic purposes as well to know the facts about stem cell and its research operations. |

|  |  |
| --- | --- |
| 12. Briefly describe each of your **data collection and analysis methods** (you may just have one method) | |
| Method 1 | Secondary data collection through Google Scholar and university database |

|  |  |  |
| --- | --- | --- |
| **13. Risks** | Explain any risks that your research participants might face because of the research project (this might include psychological and reputational risks) | Describe how you will control the risks you have identified |
| 1 | NO risk | NIL |

|  |  |
| --- | --- |
| **14. Other ethical considerations** | |
| Explain any risks that you may face as a researcher, and what steps you will take to control them.  No. | |
| Explain briefly any benefits that your research participants may gain from participation.  There is no as such benefits of researchers due to the use of their articles. However, the count of reviews will be increased effectively which can be an intangible property of the authors. | |
| Explain briefly how you will collect each type of data– such as hard copy paper / digital / audio / video.  All thee require data such as graphs and images will be collected from research articles which are collected from online resources. | |
| State a date when you will destroy by shredding, burning or deletion your data files. Note: this should be after the award of a confirmed grade for your degree.  As the information are not primary there is no need to destroy it. All the data is available in online research articles found in Google Scholar and university database. | |
| **15. Check you have considered each issue below and fully explained it in your application, then put x in the box** | |
| I have identified and taken steps to control any physical, emotional, or psychological risk to participants | Yes |
| I have identified and taken steps to control any cultural offence that might be caused | Yes |
| I have identified any vulnerable groups involved and taken steps to control the risks | Yes |
| I have explained how I will get permission from managers to recruit participants on their premises | Yes |
| I have made clear that no deception is involved in the study | Yes |
| I have explained the level of anonymity for participants and how it will be maintained | Yes |
| I have explained how participants will be informed and have the chance to ask questions beforehand | Yes |
| I have explained how participants may make follow up enquiries after their part in the study | Yes |
| I have explained how data will be kept secure and destroyed after the study | Yes |

|  |  |  |  |
| --- | --- | --- | --- |
| **16. Role** | **Name** | **e-Signature** | **Date** |
| You (Student) |  |  |  |
| Your Supervisor |  |  |  |
| Module leader or lecturer responsible for the research ethics within your programme/ module |  |  |  |

**Supportive Materials Checklist**

**Please attach all necessary supportive materials and indicate in the checklist below.**

|  |  |
| --- | --- |
| **Supportive Material** | **Version and Date** |
| Research protocol or research proposal | Version 1, March 2023 |
| Participant Information Sheet | April 2023 |
| Debriefing Sheet | April 2023 |
| Consent Form | NIL |
| Letter of invitation | NIL |
| Other (such as interview schedule, questionnaires, measures: please state, and explain) | NIL |

## Appendix 3: BUSINESS MASTERS DISSERTATION PROPOSAL

**The procedure for submission of this proposal is given in the *Dissertation Guidelines***

***Please Type in the appropriate spaces. Boxes will expand as you type.***

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Thomas Jones** | **Student Number** | **S0080133** |
| **Course** | **MBA** | | |

**Provisional Title of Your Dissertation.**

|  |
| --- |
| ***Business challenges of Stem Cell Technologies for Glioblastoma in New York, US*** |

**Describe the topic(s) or issue(s) you wish to investigate for your Dissertation.**

**These must relate to the subjects that comprise your programme of study, and must clearly indicate what your aims /objectives / research questions will be.**

|  |
| --- |
| **AIM -** This dissertation aimed at identifying the business challenges for the development and implementation of Stem cell technologies for Glioblastoma in New York, US.   * Understand contemporary theory on business challenges for stem cell development technologies for Glioblastoma in New York, US * Appreciate the importance of identifying business challenges for the development of Stem cell technologies for Glioblastoma in New York, US. * Determine the business challenges for the development of Stem cell technologies for Glioblastoma in New York, US. * Draw conclusions based on the above objectives |

**What facts or information will you need to gather? How will you access these?**

|  |
| --- |
| * **Current thinking on business practices - particularly in healthcare services sector - current textbooks and recent journal articles** * **Methodology to be developed, but likely to include selective articles related to glioblastoma.** * **Analysis of selective articles** |

**To which subject area(s) is this proposal - in your view -most strongly related?**

|  |
| --- |
| Business operations, healthcare |

**Name any tutor(s) you think might be appropriate to supervise your dissertation.**

|  |
| --- |
|  |