HIGH SCHOOL EDITION
Journal of Student Research
Volume 12 Issue 4 (2023)

# Socioeconomic Paradigms Influencing the Allocation of Oncological Therapeutics: A Comparative Study

Brandon Adams[1] and Marydell Joyce[#]

[1]Cypress Creek High School, USA
[#]Advisor

## ABSTRACT

Cancer presents a formidable globalized public health challenge with extensive socioeconomic ramifications. This paper investigates the socioeconomic optimality of mRNA-based oncological platforms concerning cancer amelioration. Quantitative analysis discerned the socioeconomic effectiveness of mRNA candidates. Clinical immunogenicity data demonstrated efficacy variability amongst platforms. Cost-benefit assessment discerned CV9202's superior cost-effectiveness, representing socioeconomic optimality. These methodological developments provide a comparative basis to contextualize implementation gaps and accessibility disparities. Socioeconomic cognizance permits tailored therapeutic accommodation for economic constraints, improving patient outcomes through optimized distribution. Further generalization necessitates extensive efficacy data over prolonged timeframes encompassing long-term immunological durability. Societal stigmatization presents additional complications. This research delineates an analytical paradigm to discern optimal therapeutic allocation given socioeconomic circumstances. Improved patient-provider relations may arise from responsive distribution models sensitive to socioeconomic factors. Optimal distribution has advantageous implications for stakeholders. Future research could assess preventative applications, combination therapies, infrastructural variables, and extensive candidates. In conclusion, this methodology demonstrates means of optimizing distribution congruent with socioeconomic factors to improve accessibility and cancer outcomes through cost-effective therapeutic platforms like mRNA vaccination.

## Introduction

Oncology as a field of study has proliferated much of medical literature with respect to academic research given the prominence of cancer diagnoses and their implications on patient and societal outcomes. Given the significance of cancer's effects in relation to medical research, it is important to effectively examine notable developments concerning therapeutical research in acting as an efficacious intervention mechanism to address the considerable incidence of cancer. Prevailing recent technological developments regarding therapeutical research within oncology are particularly eminent in the following platform-specific domains: mRNA vaccination platforms, chemotherapeutic agents, radiological therapy, and genomic editing. mRNA platforms have considerable notoriety as an effective transmission vector mechanism for the elicitation of immunological responses with the intent to facilitate adaptive immunological responses in the context of appropriately minimizing the virulence of a specified pathogen. The biomechanisms of mRNA correspond with the central dogma of biomechanics, which consists of the transcription-translation model of genetic expression regarding the formulation of proteinaceous structures. Due to mRNA's susceptibility to degradation regarding the intercellular microbiological environment corresponding to the administration or injection site, mRNA is typically encapsulated in a lipid

nanoparticulate shell to preserve the integrity and stability of mRNA transcripts from degradation by the extracellular environment and regulatory proteins in the procession of the acceptance of the mRNA transcript into the cellular membrane. After transversion of the cellular membrane, mRNA transcripts undergo translation through ribosomal structures present throughout a cell, most typically located within the cytoplasm for which mRNA strands are translated by means of tRNA (transfer RNA) that produce polypeptide chains used to synthesize complex protein structures used for the purposes of eliciting an immunological response caused by antigenic stimulation of the adaptive immune system, extracellularly. Following recognition of the corresponding synthesized antigen, the adaptive immune system is capable of recognition concerning corresponding antigen(s) in relation to a particular pathogen for which the process of immunological neutralization can occur through the use of synthesized neutralizing antigen-specific antibodies that effectively act to neutralize antigenic activity related to the designated pathogen.

## Literature Review

In reference to issues concerning the socioeconomic optimality of various mRNA-based therapeutics, mRNA-based therapeutic platforms offer considerable benefits in addressing the implementation gaps associated with cost-ineffective distribution models of cancer-related therapeutics, most notably concerning the ability of mRNA platforms to support considerable adaptability and modularity. Such characteristics pertaining to therapeutic modularity components are imperative in the assessment of the relative viability for specified therapeutical interventions, such as that of mRNA synthesis for the purposes of immunological stimulation, as described in the following periodical, “The beauty of mRNA technology is the broad bandwidth of its versatility. By modifying building blocks, structural elements, and formulations of the synthetic mRNA, a variety of features including targeting to defined cells, duration of expression, and immunological effects can be adapted. This expands the design space for mRNA beyond therapeutic cancer vaccination” (Beck et al., 2021). The particular emphasis upon the modularity components of mRNA as a form of oncological therapeutic suggests that mRNA specializes in the specific antigenic targeting of particular cancerous cells for which the behavior of such adaptive immunological cells can be adapted in accordance with desired outcomes. Therefore, consideration of patient-specific circumstances is crucial in my evaluation of deriving a comparative analysis based on inferential statistics to aptly evaluate the applicability of certain treatment options. Relating to this, it can be determined that there is a prominent gap within the evaluation of socioeconomic optimality concerning comparative therapeutic-specific cost-effectiveness which is imperative to effective public health initiatives relating to cancer. The relevance derived from such inferential evaluations characteristic of the corresponding implications of comparative circumstances attributed to various forms of oncological interventions with respect to patient-specific circumstances is in that it refines the evaluation for providing a cost-benefit analysis with respect to individualistic circumstances that would provide insight into determining the optimal form of treatment with respect to various forms of cancerous tumors, which would allow for the optimization of cancer evaluations for patients in a manner that would improve treatment outcomes on a basis of contextualization of individual characteristics to discern the implicated values concerning the facilitation of various treatment options. As such, properly addressing these aspects regarding the proper assessment of patient-specific interventions in cancer treatment will optimize the manner in which cancer is treated in clinical settings, with the intent of improving patient outcomes related to cancer as a result.

## Methodology

In order to aptly assess the comparative characteristics of various therapeutics with respect to their relative efficacy concerning the effective treatment of prognostic cancer development in patients, the utilization of differential analysis is necessitated in order to accentuate the various trade-offs associated with the usage of certain mRNA-based cancer-related therapeutics over others regarding the implementation gap concerning inadequacies in the facilitation of specific therapeutics with regard to identified patient-specific characteristics that would identify applicative interpretational attributes to discern the degree at which clinical oncological resources are not being distributed efficiently. The methodology implemented in my research to quantify the comparative cost-effectiveness is that of a cost-benefit analysis provided assessments of various mRNA-based therapeutic candidates in relation to their clinical efficacy and net incurred manufacturing-related expenditures to evaluate their socioeconomic optimality. In order to identify characteristics regarding the assessment of potential value(s) associated with optimal patient outcomes, contextualizing the limitations and biochemical characteristics of various therapeutic agents and their corresponding biochemical interactions with immunological bodies will be used to identify statistical trends when pairing the contextualization of behaviors and attributes of said therapeutic agent with respect to the efficacy data corresponding to given identifiable characteristics to assess the capability of therapeutic agents to exhibit efficacious outcomes regarding the identification and corresponding treatment regarding the development of prognostic cancer, and its corresponding implications upon patient-specific outcomes regarding cancer diagnoses. This information when paired with corresponding efficacy clinical data related to various experimental developments concerning various therapeutic agents provides insight into the relative effectiveness of which addressing the implementation gap within certain patient-specific characteristics with respect to the relative utilization of corresponding experimental therapeutics. Quantitative analysis with respect to the evaluation of experimental therapeutics relative to quantitative data provided by efficacy data provided by clinical trials corresponding to the implementation of various drugs with respect to control populations and their corresponding dependent outcome related to its efficacy and implications upon the development and occurrence of cancerous tumors over time. Based on this approach, sample sizes vary upon the scale of implementation concerning the means at which said pharmaceutical corporation is capable of facilitating, but in general is sufficient to discern highly generalizable data related to the effectiveness of therapeutic agents upon the development of cancerous tumors. Additionally, the evaluation concerning the responsiveness of said relationships between the implementation of experimental therapeutic agents relative to identified control populations signifies the potential optimization protocol in order to address the issue of implementation gaps regarding the institution of various experimental therapeutics, when differentiating between a cost-benefit analysis of specifically identified outcomes related to the means at which healthcare providers are capable of facilitating the institution of experimental therapeutics that are identified as being optimal, but for which the means of obtaining such therapeutics is inherently unattainable, and therefore would necessitate differences regarding the relative optimization of services across a significantly more generalized distribution. In the evaluation of the alleviation of implementation gaps regarding the potential for insufficient distribution of clinical resources that would need to be accounted for when considering a holistic evaluation of clinical outcomes associated with the allocation of therapeutic resources within existing infrastructure. Identifying correlational trends defined by the implementation of various therapeutic interventions regarding cancerous developments in somatic regions is of considerable importance to aptly contextualize the necessitation for facilitating a multilateral approach to addressing the allocation of therapeutic resources in a manner that is of optimal societal value, to which is quantified by the relative effectiveness concerning the institution of experimental therapeutic agents with respect to definitions of identified trends associated with systematically evaluating the relative importance considering the logistical organization of identifying differential attributions regarding therapeutic agents to specifically discern the relative importance of defining measures and/or characteristics associated with a differ-

ential analysis pertaining to identified trade-offs associated with the utilization of specified therapeutic interventions with respect to the contextualization of patient-specific characteristics that would define considerable proportions of the evaluative process in assessing the usefulness of given oncological therapeutics in response to differing circumstances. Given the considerably high degree of differentiation regarding the various forms of diagnosed cancers as well as the individual-specific genetic differentiation imposed by mutation-related substitution, the potential outcome regarding the utilization of specified forms of therapeutical drugs may differ considerably depending upon various genetic predispositions that have profound implications upon the facilitated drug effectiveness with respect to individual circumstances. In addition, the interaction of specified therapeutic drugs may differ with respect to the introduction of extraneous drugs which may pose potential issues regarding the validity of efficacy data when accounting for differentiated characteristics imposed by drug interaction. The quantification of such interactions should be considered when appropriately evaluating the quantitative relationship between the introduction of oncological therapeutics with respect to implications upon cancer-related patient outcomes, particularly involving the development of post-prognostic cancerous tumors, as well as differentiation in cancer outcomes that are undergoing the process of metastasis, which represents a critical component of assessing therapeutic efficacy in the context of terminal illness in which encompasses a particularly notable concern amongst the implications for which cancer poses upon society. Stigmatization of cancer-related topics, issues, or concerns is also of considerable importance when assessing the implementation of oncological therapeutics in that negative societal prototypes devised with particular concern for induced sentiments of abstention from obtaining critical experimental therapeutics may provide a particularly significant setback for expanding accessibility to said treatment services, as stigmatization against terminal illnesses may disenfranchise individuals from accessing critical means of cancer-related treatment, which can have a particularly significant extraneous influence upon the implementation gap previously identified. These identified negative societal incentives can influence the results discerned from the identification of quantifying variable-related relationships within clinical studies, in that a component of clinical studies that may not be accounted for with regard to clinical generalization is that of societal stigmatization towards perceptions of those suffering from terminal illnesses such as cancer, for which in societal practice at a wider population scale, would therefore begin to skew quantified outcomes based upon the premise of lower than expected population uptake then what was observed through quantified studies. A quantifiable evaluation of competitive characteristics and identified outcomes related to the interactions of corresponding variables influencing the outcomes of patient-specific instances and occurrences of cancer diagnoses therefore allows for the contextualized assessment of therapeutic-specific effectiveness on a societal scale.

## Findings

In the investigation of the inquiry into the comparative aspects and continuities in experimental therapeutic interventions concerning cancer-related developments; various statistical disparities regarding clinical availability must be identified when assessing the efficacy of therapeutic drugs. Therefore, a new understanding regarding the assessment of the effectiveness of cancer-related therapeutic drugs concerning situational factors by means of a comparative study is vital to aptly allocate clinical resources with particular concern to socioeconomic availability. The various therapeutic platforms assessed in this study are mRNA vaccination platforms.

Based on the importance of considering the consideration of socioeconomic availability of clinical therapeutics on a basis of need-based determinism, a cost-benefit analysis with respect to interpreting the optimum distribution of experimental therapeutics corresponding to efficacy data is imperative to establish in order to contextualize this subject matter. Meticulous consideration of economic burdens is fundamental in constructing a novel understanding concerning the optimum platform of cancer-related treatment based upon the premise of socioeconomic conditions. Based on these approximated economic burdens and their corresponding efficacy

data, a statistical model can be established for establishing an inquiry into the relative effectiveness representative of various socioeconomic circumstances to derive minimal socioeconomic burden(s) incurred.

In this particular study, specified variables are evaluated to contextualize socioeconomic availability which includes therapeutic clinical drug efficacy data, associated drug manufacturing and distribution-related costs, socioeconomic patient-specific demographics, and infrastructural-related factors/resources. Specific definitional details concerning the aforementioned variables are outlined in Table A, as illustrated below.

**Table 1.** Identification and definition of variables evaluated in this study.

| Considered socioeconomic variable(s) | Variable-specific identification |
|---|---|
| Clinical therapeutic drug efficacy | Evaluated through clinical trial data and/or publications regarding the efficacy of various therapeutic platforms in cancer-related outcomes. |
| Manufacturing/Distribution costs of therapeutic platforms | Assessed using cost analyses of various therapeutic drugs with respect to production-related and distribution-related incurred costs. |

The most important component in evaluating the optimum distribution to address the implementation gap concerning the optimal utilization and uptake of cancer-related experimental therapeutics is that of clinical trial efficacy, given that the elicitation of intended biological responses is the key incentivization for therapeutics drugs to be classified as socioeconomically viable in societal-related contexts.

**Table 2.** Clinically Obtained Immunologic Elicitation Data for Cancer-Related mRNA Platforms: Modified from Miao et al., 2021.

| mRNA Vaccination Platform Investigated (Clinical Phase) | Percentage of Patients Experiencing an Immunological Response |
|---|---|
| MRNA-4157/V940 w/ KEYTRUDA[1] (Phase II) | 44% |
| mRNA-2752 (Phase I) | 52% (tumor reduction) |
| TriMixDC-MEL (Phase II) | 50.7% (comparative between experimental/control groups) |
| IVAC MUTANOME (Phase I) | 60% (elicited a response) |
| CV9202 (Phase I/II) | 84% (elicited a response) |

[1] The data entry regarding the immunological responsiveness observed in clinical trials for mRNA-4157/V940 w/ KEYTRUDA[1] is actively using combination therapy techniques paired with the immunotherapeutic regiment KEYTRUDA.

In Table 2 presented above, the immunological responsiveness in patients observed in a diverse range of clinical studies examining the effectiveness of various cancer-related mRNA vaccination candidates is expressed as a percentage of clinical trial participants. In the clinical trial data concerning immunogenicity, there is statistically significant heterogeneity in relation to the proportion of immunostimulation recorded with respect to the various mRNA immunization platforms investigated. The information presented in Table 2 suggests that mRNA candidates IVAC MUTANOME and CV9202 elicited the most potent immunostimulatory adaptive immune response.

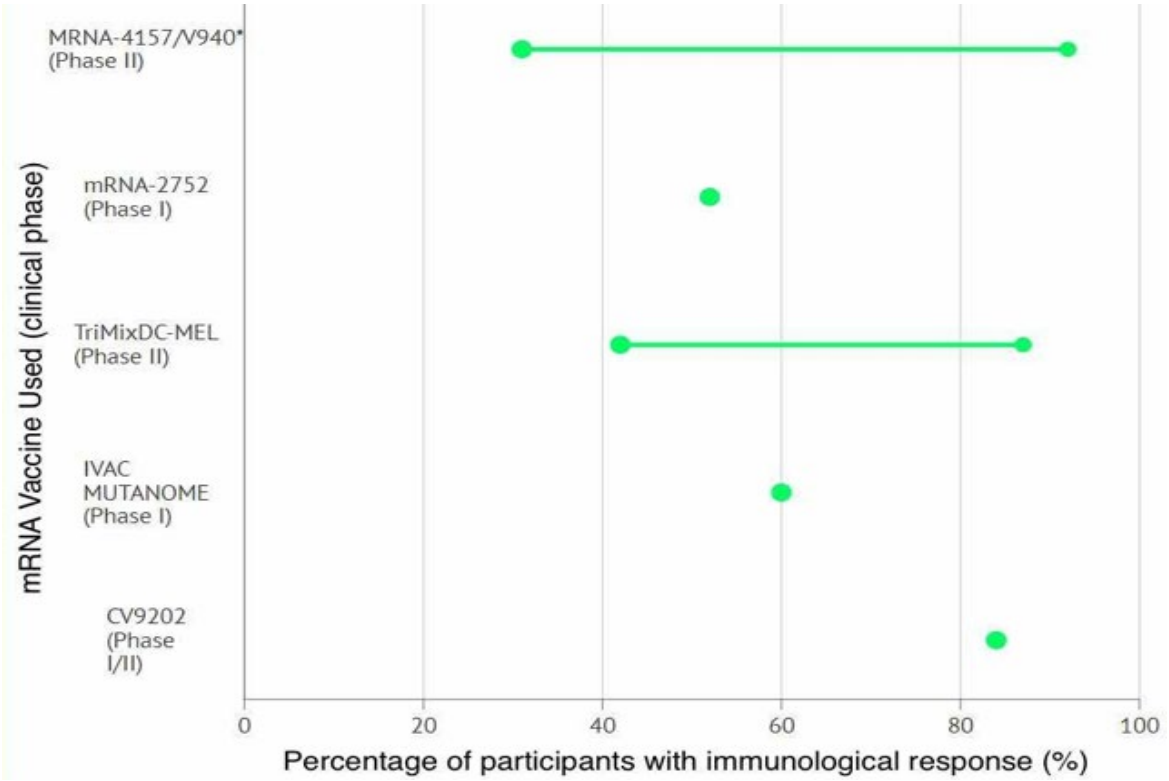


**Figure 1.** Comparison of mRNA Vaccination Platform and Immunological Response Percentages in Humoral Immunogenicity: Adapted from Miao et al., 2021. The data entry pertaining to the immunological elicitation expressed as a percentage for mRNA candidate mRNA-4157/V940* was recorded as a co-administered medication with KEYTRUDA in clinical trials.

The range plot illustrated in Figure 1 provides a visualization of the comparative relationship concerning five experimental cancer-related mRNA vaccine candidates whereupon the y-axis represents the various mRNA cancer-related vaccines investigated, and the y-axis depicts the percentage of patients from which an immunological response was elicited. The two extremities depicted as minimum and maximum values for each candidate are calculated in accordance with data-related confidence intervals to ascertain a calculated range of statistically possible immunological elicitation rates. The data depicted by the range plot suggests disparities concerning the potency of immunological elicitation in cancer patients.

**Table 3.** Cost-benefit Analysis of mRNA Cancer-related Vaccines Expressed as Cost Per Unit of Elicitation: Adapted from Miao et al., 2021; and Light & Lexchin, 2021.

| Candidate mRNA Vaccine Administered (Clinical Phase) | Cost Per Unit of Immunological Elicitation (In Dollars/Percent Elicitation) |
|---|---|
| mRNA-4157/V940 w/ KEYTRUDA[1] (Phase II) | $1.23-$2.23 |
| mRNA-2752 (Phase I) | $1.04-$1.88 |
| TriMixDC-MEL (Phase II) | $1.07-$1.93 |
| IVAC MUTANOME (Phase I) | $0.90-$1.63 |

| | |
|---|---|
| CV9202 (Phase I/II) | $0.64-$1.17 |

[1] The calculated values concerning incurred costs per unit of immunological responsiveness for mRNA-4157/V940 w/KEYTRUDA[1] do not account for therapeutic expenditures related to KEYTRUDA.

This table illustrates a cost-benefit analysis calculated as an expression of the incurred costs per unit of immunological elicitation and represented in United States Dollars, provided alongside estimated figures concerning the net incurred costs of mRNA vaccination platforms presented by Light and Lexchin. These assessments are essential in delineating the most socioeconomically optimal mRNA-based cancer-remedial therapeutic in the alleviation of inefficient distribution concerning socioeconomic circumstances. The examination of cost-effectiveness related to the implementation of various candidate mRNA-based platforms is an imperative consideration and component of informed pharmaceutical allocation models.

**Table 4.** Average Estimated Net Production Costs Per Unit of Immunological Elicitation for Cancer-Related mRNA Vaccine Candidates: Adapted from Miao et al., 2021; and Light & Lexchin, 2021.

| Candidate mRNA Vaccine Administered (Clinical Phase) | Average Estimated Cost Per Unit of Immunological Elicitation (In Dollars/Percent Elicitation) |
|---|---|
| mRNA-4157/V940 w/ KEYTRUDA[1] (Phase II) | $1.73 |
| mRNA-2752 (Phase I) | $1.46 |
| TriMixDC-MEL (Phase II) | $1.50 |
| IVAC MUTANOME (Phase I) | $1.27 |
| CV9202 (Phase I/II) | $0.91 |

[1]The provided average denominations representing incurred costs per unit of immunological responsiveness for mRNA-4157/V940 w/KEYTRUDA[1] do not consider therapeutic expenses related to the use of KEYTRUDA.

The data represented in Table 4 depicts a calculated mean concerning the estimation of incurred net manufacturing costs expressed per unit of immunological elicitation amongst the five candidate mRNA-based vaccines with respect to cancer-related outcomes. These calculations depict statistically notable disparities concerning the cost-effectiveness of each candidate, which ranges from $0.91 to $1.73 across the mRNA platforms assessed. Such production-related costs are imperative in ascertaining a definitive assessment concerning socioeconomically optimal therapeutic platforms considering that such aforementioned manufacturing costs will inevitably be imposed upon consumers.

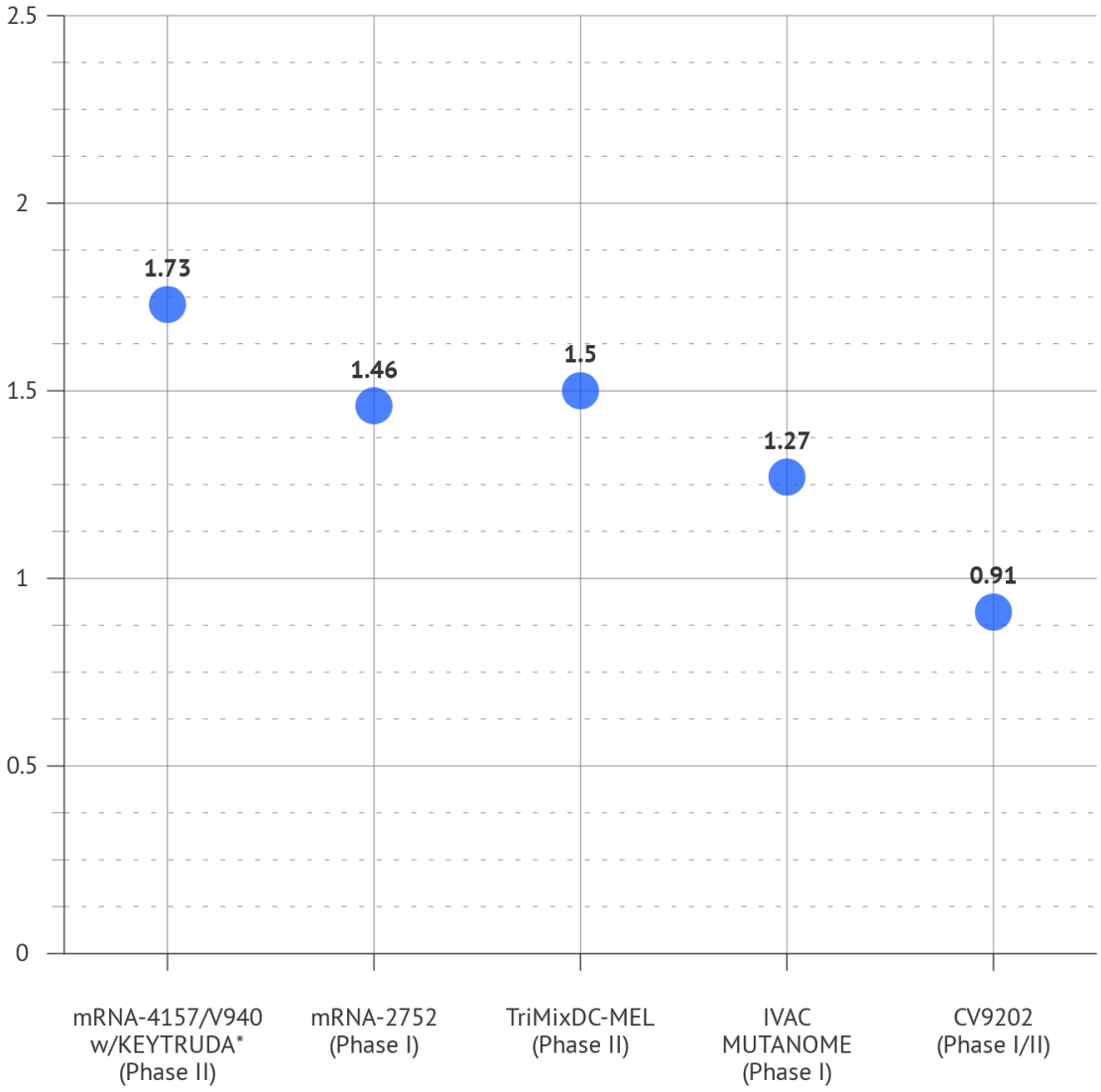


**Figure 2.** Mean Estimated Net Incurred Production Costs per Unit of Immunological Elicitation

The scatterplot depicted in Figure 2 presents the calculated mean concerning the range in cost estimates regarding net production costs per unit of elicited immunologic responses amongst various mRNA-based therapeutics. The visualization of cost-effectiveness regarding mRNA-based platforms in the context of cancer remediation demonstrates a statistical disposition related to quantitative disparities amidst the investigated mRNA vaccination candidates and provides essential contextualization upon discerning the most cost-effective therapeutic in the consideration of socioeconomically optimal distribution models.

However, there do exist statistical limitations to this evaluation with respect to population generalization. There is considerable variability with respect to the accessibility of prerequisite infrastructure to support the facilitation of the transportation and administration of corresponding drugs, the availability of which is highly variable with respect to situational factors which are necessary to assess alongside the identification of optimum regiments concerning socioeconomic availability. This may also influence the costs incurred if there is inadequate infrastructure to facilitate the administration of experimental therapeutics that may deviate from

these assessments. An instance of this phenomenon would be that of the costly refrigeration techniques necessitated for the stability of mRNA vaccination platforms that would inherently be challenging for developing countries with limited infrastructural capabilities or rural regions in which the costs incurred per capita would be considerably larger due to sparse population density.

## Discussion

The purpose of my conducted research is to investigate the socioeconomic optimality of various mRNA-based therapeutic drugs concerning cancer remediation in the context of socioeconomic predispositions; with the objective of maximizing drug-related distribution efficacy in the process of identifying optimal cost-effective solutions regarding observances of disproportionalities concerning cancer-related patient outcomes. The quantified statistical developments explicated in my paper suggest a substantial disparity in the viability and cost-effectiveness of various mRNA-based therapeutic platforms concerning cancer-related applications in assessing distribution-specific socioeconomic optimality. An illustration of this disparity principle concerning the viability of various candidate mRNA-based platforms, the adapted calculations regarding the mean clinical immunogenicity outlined in Table 2, suggest considerable variance in immunologic responsiveness across various mRNA-based therapeutic platforms in inducing immunostimulatory activities regarding adaptive immunological reactivity. These findings imply the presence of considerable variations regarding the effective capacity of various mRNA-based therapeutic platforms to effectively achieve desired immunomodulatory reactions necessitated for efficacious neoplasm-specific remediation in cancer patients. However, Figure 1 suggests that contrary to the quantitative propensities delineated in Table 2, there exists an extensive range of indeterminacy concerning existing confidence intervals, and definitive conclusions pertaining to the viability of experimental candidate mRNA-based platforms in remediating cancer-related outcomes may not be so unequivocal. This statistical uncertainty concerning the ascertainment of efficacy-related data of mRNA-based cancer-related platforms is likely attributable to the currently experimental nature concerning the applicability and suitability of mRNA vaccination platforms as an efficacious therapy concerning oncological amelioration in existing neoplastic cases. This statistical circumstance appears to be ascribed to the characteristics of early-phase clinical trials regarding therapeutic developments, wherein the entirety of the collective aggregate of assessed mRNA-based vaccination platforms investigated in my research are presently situated in Phase I and Phase II of clinical development trials from which the immunogenicity-related data was evaluated. This arisen limitation in early-phase clinical trials is predominately the result of relatively small or demographically limited sample sizes that have a tendency to provide more inconclusive results concerning efficacy-related data and complicate the generalizability of findings across a diverse population.

The findings formulated in Table 3 represent a cost-benefit assessment concerning the assessed estimation of the net manufacturing expenditures related to the large-scale manufacturing of cancer-related mRNA platforms, the expenses of which are illustrated on a per-unit basis representative of a single administrative dose. Monetary estimates relating to the evaluation of net manufacturing costs on a per-dose basis were derived from a publication by Donald W. Light and Joel Lexchin titled *The costs of coronavirus vaccines and their pricing*, in which quantitative estimations regarding net production costs associated with the implementation of mRNA-based therapeutic platforms was approximated to be within the range of $0.54-$0.98 per dose manufactured, in which the monetary estimations were denominated in United States Dollars. These estimated monetary appraisements concerning net production costs were principally based upon assessments of the cost of capital necessitated for large-scale manufacturing production by previously existing facilities engaged in mRNA platform manufacturing, in correspondence with estimated incurred costs concerning employment-related expenditures, as well as the expenses related to components and substances within mRNA vaccination platforms provided by reports of pharmaceutical manufacturer Johnson and Johnson's reported dosage-related costs; these calculated per-unit expenditures were scaled to approximately 100 million manufactured units

(Light & Lexchin, 2021). Therefore, in ascertaining cost-related estimates concerning mRNA-based therapeutics on a per-unit basis, an assessment based upon previous iterations regarding the implementation of mRNA platforms in relation to public health initiatives such as SARS-CoV-2 (COVID-19) is essential in the examination of the cost-effectiveness of various mRNA-based candidates methodologically in regards to discerning the most socioeconomically optimal mRNA-based platform for the purposes of determining the ideal allocation of cancer-related therapeutics given social and economic patient-specific circumstances. Taking into account these per-unit approximations, the relative cost-effectiveness of various mRNA-based therapeutics can be assessed comparatively through my methodological approach of calculations pertaining to the assessed costs per dose denominated in United States Dollars per unit of immunological elicitation assessed in clinical trials expressed as a decimal value amongst the investigated mRNA-based vaccination candidates based upon existing expenditure estimation ranges provided by Light and Lexchin. Provided these estimated cost-related figures and clinical trial data pertaining to therapeutic-specific immunogenicity, a comparative relationship concerning the relative cost-effectiveness of the mRNA-based candidates being investigated in this paper is established, illustrated by the cost per unit of elicitation outlined in Table 3. The range-specific minimum and maximum values illustrated in Table 3 for each inquired mRNA-based therapeutic solution are reflective of the statistical range of uncertainty adapted from Light and Lexchin's findings. However, it is worth considering that there are notable confounding variables that may complicate this cost-effective analysis, namely the size, and scale of production of pharmaceutical manufacturers, as well as discrepancies in research-related costs associated with the development of mRNA-based therapeutics in relation to an assortment of various distinct instances of neoplastic developments that may incur differing research-related expenditures.

Table 4 illustrates a unidimensional analysis concerning statistical developments regarding the methodological approach in relation to the estimation of calculated net production costs per unit of immunogenic responsiveness pertaining to investigated mRNA-based therapeutic platforms in the application of neoplastic remediation. The calculation pertaining to the ascertained mean values regarding estimated expenditures per unit of immunological responsiveness represented in Table 4 was evaluated by determining the statistical average within the lower and upper numerical boundaries encompassing the range of uncertainty provided by expense-related estimates. This particular unidimensional approach regarding data organization is essential in establishing discernible analytical inclinations concerning the relative cost-effectiveness of various mRNA-based platforms that are being investigated in my research. Pertinently, the cost-benefit assessment depicted in Table 4 demonstrates that candidate drug CV9202, in particular, provides the most socioeconomically optimal cost-related platform pertaining to the capability of yielding the most potent adaptive immunogenic responses in relation to the least incurred socioeconomic burden imposed upon consumers in the contextualization of socioeconomic disparities, represented as $0.91 per unit of immunostimulatory responsiveness.

The information in Figure 2 is conveyed by a scatterplot from which the relative cost-effectiveness of the inquired experimental mRNA-based vaccination platforms can be visualized, in regard to the relationship between the experimental mRNA candidates and their relative cost-effectiveness determined in my research computation through a methodological cost-benefit analysis approach. The analytical correlations depicted in the aforementioned scatterplot illustrated in Figure 2 suggest notable deviations regarding the cost-effectiveness in relation to immunologic responsiveness across the inquired experimental mRNA-based platforms investigated throughout my research process. Particularly, mRNA-based candidate CV9202 demonstrates the most statistically significant cost-effectiveness in relation to its allocative implementation in socioeconomic contexts due to its optimum immunological elicitation exhibited in obtained clinical trial data, in correspondence with its maximized manufacturing-related efficiency described in my methodological assessment of comparative cost-benefit approaches amongst the mRNA-based candidates investigated. However, it is important to note that associated incurred production-centric costs may fluctuate depending upon proprietor components of manufacturer-specific platforms that may influence a platform's cost-effectiveness in non-competitive macroeco-

nomic circumstances within the pharmaceutical industry. Given the circumstances of production-related confidentiality amongst pharmaceutical manufacturers, more precise approximations upon the evaluation of platform-specific cost-effectiveness may limit more definitive conclusions concerning socioeconomically optimal therapeutic approaches outlined in my research.

The cost-benefit comparative approach developed throughout my research process represents advantageous insights in developing a cost-effective approach regarding the implementation of therapeutic distribution in the context of socioeconomic optimality in comparison to various candidate mRNA-based therapeutics investigated in my methodological evaluative process, which accentuates the cost-related potential of therapeutic candidate CV9202 in terms of its socioeconomic optimality in reference to other mRNA-based alternatives. The methodological-related approaches employed in the investigation of socioeconomically optimal cancer-related therapeutics within my research emphasize the pharmaceutical potential and viability in medical contexts, particularly in reference to its socioeconomic prospects in enhancing the accessibility of therapeutic interventions in minimizing preventable neoplastic progression and mortality, as well as establishing beneficial relations amongst patients and public health institutions alike.

## Conclusion

In the investigation concerning the methodological evaluation of various mRNA-based therapeutics involved in cancer remediation, I established a particular emphasis on inquiring about the comparative cost-effectiveness in relation to a variety of identified mRNA candidates through an analytical cost-benefit assessment in the context of socioeconomic disparities affecting the accessibility of remedial therapeutics regarding cancer-related outcomes. In correspondence with my methodological approach concerning the evaluation of the quantifiable cost-effectiveness of the inquired mRNA-based platforms, the findings of my research suggest that the mRNA vaccination platform candidate CV9202 is a highly promising solution concerning the implementation and allocative gap associated with the inefficient distribution of therapeutics in the context of socioeconomic optimality. Candidate CV9202 specifically represented the most statistically significant socioeconomic optimality in regards to exhibiting the least incurred net production-related costs per unit of immunogenic responsiveness and therefore indicates very prospective results in providing more cost-effective and subsequently more accessible platforms concerning existing patient-specific socioeconomic disparities implicating inequitable clinical-related outcomes. The socioeconomic ramifications relating to the optimization of therapeutic-related distribution have the potential to address patient-specific predispositions that often challenge effectual public health initiatives relating to cancer amelioration, the resultant consequences of these socioeconomic adversities often contribute to the substantial burdens imposed by cancer incidence on a wider societal level. These delineated findings outlined in my research characterize notable potentiality to accommodate more socioeconomically efficient and optimal means of distribution that are cognizant of social and economic disparities that permeate the nexus of health-related services, the latter of which is often a matter of significant concern for healthcare policymakers and health-related administrative bodies. In the recognition of the formidable and profound challenges associated with cancer being among the foremost tribulations facing present-day society from a public health perspective, the optimization of distribution-related approaches is imperative in effectively addressing the considerable burden that cancer imposes, the afflictions which impact innumerable stakeholders, and in the assessment of therapeutic-related distribution with consideration of socioeconomic predispositions and maximizing cost-effectiveness, we can ameliorate a considerable strain that disproportionately affects the most socioeconomically disadvantaged members of society who often experience the greatest challenges regarding therapeutic availability. These ramifications not only encompass addressing the socioeconomic needs of individual patients but also implicate advantageous values for health-related institutions. In the optimization of cost-related efficiency, healthcare expenditures concerning medical service providers would also entail the minimization of healthcare-related expenditures that often dictate the expenses related to health services, thus

curtailing incurred costs in relation to supply and demand components of macroeconomic stakeholders in the oncological industry.

The intuitive nature of the findings of my research presents abundant opportunities regarding the potential for future research in this particular discipline of oncological-related research that builds upon or extends the scope of applicability of my findings. Given the immunostimulatory properties associated with mRNA vaccination platforms, future research into the prophylactic applications of mRNA-based therapeutic platforms represents a particularly notable extension of the applicability of my findings, in consideration of preventative adaptations of this approach concerning cancer remediation regarding large-scale cancer incidence prevention, which represents an alternative approach to my post-diagnostic applications of mRNA-based therapeutics regarding neoplastic developments. Furthermore, further research with the potential of conducting cost-effective analyses with additional candidates has the potential to increase the generalizability of my existing findings through the inclusion of a broader range of candidates. Additionally, combination therapy involving the integration of a plurality of vaccination platforms could provide insight into the enhancement of therapeutic efficacy and relative cost-effectiveness. Moreover, future inquiry into geospatial and infrastructural variables influencing the relatively standardized methodology to establish my findings may provide a multidimensional approach to further contextualizing socioeconomic predispositions in relation to mRNA-based therapeutics in regard to cancer-related outcomes.

## Limitations

Compiled clinical data that is essential to contextualizing the practicality of mRNA-based platform therapeutics is comparatively limited with respect to extensively generalizable trial results characteristic of comprehensive late-phase clinical study assessments necessitated for large-scale applicability of clinical findings in the findings presented in this paper due to the experimental nature of mRNA-related platforms when applied to oncological research. Consequently, the relatively novel approach concerning the implementation of mRNA-related platforms entails notable limitations in the applicability of the most socioeconomically optimal therapeutic developed in the analytical methodology of this paper.

Moreover, the empirical conditions governing cancer-related mRNA therapeutics inherently present limitations in yielding vital long-term efficacy figures over extended time intervals, which constrains the ability of available therapeutic trial data to establish more definitive conclusions regarding aptly assessing the optimum socioeconomic distribution regarding various mRNA-based therapeutics. Furthermore, the notion of protracted diminishment of therapeutic potency in the context of mRNA-based therapeutics is frequently recognized conceptually through the vaccine-induced waning of immunity in describing the tendency of statistical declinations in therapeutic efficacy over time and is substantiated by demonstrations of antecedent instances of immunological elucidated regression over a protracted timeframe. The absence of extensive long-term clinical trial data regarding cancer-related mRNA therapeutic platforms complicates the resoluteness of conclusions concerning optimum therapeutic distribution.

Furthermore, the multifaceted complexion of malignancy constitutes substantive heterogeneity pertaining to the extent of extrapolation of methodological cost-benefit analyses related to socially optimum conditions. Phenotypic plasticity presents considerable complications regarding therapeutic efficacy, particularly in assessing long-term efficacious characteristics, which complicates per-unit evaluations implemented in my approach with reference to the initial evaluations pertaining to immunological therapeutic elicitation responses. Achieving a more nuanced ascertainment of patient-specific characteristics and disparities to effectively facilitate targeted therapeutic interventions that adequately rectify the biopharmaceutical challenges regarding the heterogeneity of neoplasms. Subsequently, immunological discrepancies concerning immunomodulation induce notable limitations in examining the therapeutic effectiveness observed in clinical trials. The manifestation of antigenic escape in neoplastic cells demonstrates an onerous hindrance in eliciting potent immunological

responses in relation to tumor cells of focus, as it impedes the ability of the adaptive immune system to identify and discern specified identifiable antigens necessitated for effective intercellular recognition thus undermining the effectiveness of acquired immunity in inducing the intended immunological response. Likewise, the implementation of my methodology had not accounted for extraneous circumstances such as acquired resistance to elicited immunological responses that may present implications regarding implicated effectiveness.

## Implications

The inherent modularity of mRNA platforms when applied to the context of cancer-related therapeutics facilitates greater flexibility and versatility pertaining to the manufacturing and research domains that can be attributed to its adaptability. The platform's adaptable capabilities characteristic of mRNA-based vaccination platforms accord remarkable versatility in relation to manufacturing scalability and the accommodation of narrower production timeframes. Additionally, the modular attributes of mRNA-based platforms enable logistical flexibility on the part of biopharmaceutical manufacturers to support numerous therapeutic products built upon a pre-existing mRNA-based platform. Correspondingly, mRNA-based approaches minimize the quantity of time and manufacturing costs typically associated with therapeutic manufacturing and development. The aforementioned modularity of mRNA-based vaccination platforms in the context of cancer-related therapeutics expedites the capability of therapeutic refinement and enhancement regarding platform formulation and administration of mRNA-based therapeutics, thus optimizing the potency and versatility of mRNA-based platforms concerning the pharmaceutical approach of neoplastic tumors. By optimizing the biopharmaceutical approach regarding cancer-related therapeutics, such platform development has the capability to maximize advantageous patient-specific outcomes substantiated by a socioeconomic optimal methodology concerning effective dissemination and distribution of effectual cancer-related therapeutics, which is critical in the holistic assessment of ascertaining the socioeconomically optimal value associated with various mRNA therapeutics.

Furthermore, it is of paramount importance in the assessment of optimal socioeconomic mRNA-based therapeutics to contemplate the socioeconomic ramifications concerning formidable societal burdens imposed by cancer-related diseases, most notably for disenfranchised or underrepresented demographics, for which the societally efficient allocation and implementation of cancer-related therapeutics are of particular importance in minimizing preventable illness-related premature mortalities stemming from therapeutic distribution-related ineffectiveness. Of commensurate importance, optimal socioeconomic therapeutic distribution has considerable implications upon a public health institution's ability to provide adequate and adaptable accommodation for economic disparities that present hindrances in an individual's ability to receive adequate public health services. In acknowledging and appropriately implementing these identified socioeconomic discrepancies associated with variable health-related outcomes, mRNA cancer-related therapeutics can be apportioned on a need-based distribution model that prioritizes the assessment of contextualizing patient-specific circumstances to attain the most optimal cancer-related outcomes possible based on available pharmaceutical resources. In operationalizing this need-based distribution model, enhanced relations among public health institutions and medical service recipients can be established, catalyzed by a reformed distributional approach that is responsive to patients' specific needs and concerns. Given that constructive and well-established relations are imperative for effective public health initiatives, the implementation of this need-based approach has considerable outcome-related benefits for patients.

## Acknowledgments

I would like to thank my advisor for the valuable insight provided to me on this topic.

## References

Miao, L., Zhang, Y., & Huang, L. (2021, February 25). MRNA vaccine for cancer immunotherapy - molecular cancer. BioMed Central. Retrieved April 29, 2023, from https://molecular-cancer.biomedcentral.com/articles/10.1186/s12943-021-01335-5

Beatty, G. L., & Gladney, W. L. (2015, February 15). Immune escape mechanisms as a guide for cancer immunotherapy. Clinical cancer research : an official journal of the American Association for Cancer Research. Retrieved May 1, 2023, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4334715/

Moderna and Merck announce mrna-4157/V940, an investigational personalized mrna cancer vaccine, in combination with keytruda(r) (pembrolizumab), met primary efficacy endpoint in phase 2B KEYNOTE-942 trial. Moderna and Merck Announce mRNA-4157/V940, an Investigational Personalized mRNA Cancer Vaccine, in Combination with KEYTRUDA(R) (pembrolizumab), Met Primary Efficacy Endpoint in Phase 2b KEYNOTE-942 Trial. (2022, December 13). Retrieved May 1, 2023, from https://investors.modernatx.com/news/news-details/2022/Moderna-and-Merck-Announce-mRNA-4157V940-an-Investigational-Personalized-mRNA-Cancer-Vaccine-in-Combination-with-KEYTRUDAR-pembrolizumab-Met-Primary-Efficacy-Endpoint-in-Phase-2b-KEYNOTE-942-Trial/default.aspx

Huang, L., Zhang, Y., & Miao, L. (2021, February 25). A phase I study of mRNA-2752, a lipid nanoparticle encapsulating mrnas ... mRNA vaccine for cancer immunotherapy. Retrieved May 1, 2023, from https://ascopubs.org/doi/abs/10.1200/JCO.2020.38.15_suppl.3092

Miao, L., Zhang, Y., & Huang, L. (2021, February 25). MRNA vaccine for cancer immunotherapy - molecular cancer. BioMed Central. Retrieved May 1, 2023, from https://molecular-cancer.biomedcentral.com/articles/10.1186/s12943-021-01335-5/tables/1

Miao, L., Zhang, Y., & Huang, L. (2021, February 25). MRNA vaccine for cancer immunotherapy - molecular cancer. BioMed Central. Retrieved May 1, 2023, from https://molecular-cancer.biomedcentral.com/articles/10.1186/s12943-021-01335-5/tables/1

Miao, L., Zhang, Y., & Huang, L. (2021, February 25). MRNA vaccine for cancer immunotherapy - molecular cancer. BioMed Central. Retrieved May 1, 2023, from https://molecular-cancer.biomedcentral.com/articles/10.1186/s12943-021-01335-5/tables/3

Miao, L., Zhang, Y., & Huang, L. (2021, February 25). MRNA vaccine for cancer immunotherapy - molecular cancer. BioMed Central. Retrieved May 1, 2023, from https://molecular-cancer.biomedcentral.com/articles/10.1186/s12943-021-01335-5/tables/2

Clegg, L. X., Reichman, M. E., Miller, B. A., Hankey, B. F., Singh, G. K., Lin, Y. D., Goodman, M. T., Lynch, C. F., Schwartz, S. M., Chen, V. W., Bernstein, L., Gomez, S. L., Graff, J. J., Lin, C. C., Johnson, N. J., & Edwards, B. K. (2009, May). Impact of socioeconomic status on cancer incidence and stage at diagnosis: Selected findings from the surveillance, epidemiology, and end results: National Longitudinal Mortality Study. Cancer causes & control : CCC. Retrieved May 1, 2023, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2711979/

Joseph M. Unger, P. D. (2018, August 17). Survival outcomes for rural vs urban patients with cancer in clinical trials. JAMA Network Open. Retrieved May 1, 2023, from https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2696871

Hovanec, J., Siemiatycki, J., Conway, D. I., Olsson, A., Stücker, I., Guida, F., Jöckel, K.-H., Pohlabeln, H., Ahrens, W., Brüske, I., Wichmann, H.-E., Gustavsson, P., Consonni, D., Merletti, F., Richiardi, L., Simonato, L., Fortes, C., Parent, M.-E., McLaughlin, J., … Behrens, T. (2018, February). Lung cancer and socioeconomic status in a pooled analysis of case-control studies. PLOS ONE. Retrieved May 1, 2023, from https://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0192999

Wilgenhof, S., Corthals, J., Heirman, C., Neyns, B., & Thielemans, K. (2015, November 4). Clinical trials with mrna electroporated dendritic cells for stage III/IV Melanoma Patients - Journal for immunotherapy of cancer. BioMed Central. Retrieved May 1, 2023, from https://jitc.biomedcentral.com/articles/10.1186/2051-1426-3-S2-P211

Light, D. W., & Lexchin, J. (2021, November 3). The costs of coronavirus vaccines and their pricing. The Costs of Coronavirus Vaccines and Their Pricing. Retrieved May 2, 2023, from https://journals.sagepub.com/doi/full/10.1177/01410768211053006

Beck, J. D., Reidenbach, D., Salomon, N., Sahin, U., Türeci, &O., Vormehr, M., & Kranz, L. M. (2021, April 15). MRNA therapeutics in cancer immunotherapy - molecular cancer. BioMed Central. Retrieved May 1, 2023, from https://molecular-cancer.biomedcentral.com/articles/10.1186/s12943-021-01348-0