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ORIGINAL RESEARCH

Substantial Increase in the Costs of Antineoplastic Agents in the USA from 2010 to 2021

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Purpose: This study provides one of the few national comparisons of antineoplastic expenditures from 2010 to 2021, offering new insight into how spending patterns have evolved over the past decade. In addition, it examines how out-of-pocket expenses relate to patient quality of life, an essential domain to evaluate healthcare interventions.

Patients and Methods: This study provides an updated estimate of the costs of antineoplastic agents using 2021 data and compares them with estimates from 2010. Medical Expenditures Panel Survey (MEPS) files were analyzed for national estimates. Antineoplastic treatment was defined in the MEPS using Multum Lexicon variables from the Cerner Multum. All reported prescriptions and refills were included in the expense and usage estimates. The 2010 costs were adjusted to 2021 figures using the consumer price index for out-of-pocket expenses and gross domestic products for third-party payers. SAS Studio 3.81 (Enterprise Edition) was employed for analysis.

Results: Between 2010 and 2021, cancer diagnoses in the United States rose by 20.46%, while patients getting antineoplastic therapy increased by 7.6%. During this time, the cost of these medicines increased by thrice, from $9.78 billion to $35.12 billion. Prescription numbers were steady, with an average of four per patient per year. Males, older patients, and the insured were more likely to use the service. Breast cancer was the most common, with prostate and skin cancers increasing. The average prescription expenditure for cancer patients increased significantly compared to non-cancer individuals. Finally, there was no significant relationship observed between patients' quality of life and their out-of-pocket expenses.

Conclusion: The substantial increase in cancer treatment expenses had no positive impact on patients' physical or mental well-being. This cost-quality gap necessitates a study on spending efficiency and patient well-being.

Keywords: oncology, antineoplastic agents, expenditures, utilization, national cancer estimates

Introduction

Cancer is the leading cause of death globally, with over 10 million fatalities in 2020.[1] Additionally, the incidence of cancer peaked that year, with 18 million new cancer diagnoses reported.2 Alarmingly, the number of cancer patients is projected to rise by at least 50% over the next two decades.[2] The American Cancer Society categorizes cancer treatments into two groups. The first group includes local treatments, including surgery and radiation. The second group includes systemic treatments, such as chemotherapy, immunotherapy, and targeted therapies.[3] Systemic agents, particularly antineoplastic agents, are widely used in cancer treatment.[4] Despite differing definitions, antineoplastic agents generally include alkylating agents, antimetabolites, natural products, hormones, antagonists, and miscellaneous antineoplastics.[4]

While global cancer expenditures continue to rise, the United States represents one of the highest-spending countries on oncology care, making it an essential context for understanding national treatment costs and financial burden.[5] Healthcare coverage in the United States is complex. The government has mandated cancer care through the Affordable Care Act, Medicaid, and Medicare, providing financial assistance. Charity and innovative payment structures are also utilized.[5]

In 2021, the US Food and Drug Administration had one of the highest approvals for new molecular entities, with oncology treatments accounting for one-third of submissions.[6] Over the past decade, the use of antineoplastic agents has

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surged by more than 600%.[7] Despite advancements, challenges persist due to the heterogeneity of tumors and diverse treatment mechanisms.[8] Balancing the need for treatment with rising costs presents a significant challenge for international health bodies.[6,7] Emphasizing the value of treatment can help establish a more rigorous approval process.[9] The economic approach to determining treatment value involves two major components: (1) the cost of treatment and (2) the output, which can vary based on perspective.[10] Understanding US antineoplastic spending is particularly important given the rapid approval of high-cost oncology agents and the increasing reliance on outpatient prescription therapies.

Despite extensive research on the economic burden of cancer, few studies have examined the cost of antineoplastic medications or included patient-reported outcomes.[11–13] Therefore, this study provides updated estimates of antineoplastic agent costs using 2021 data and compares them with 2010 estimates. Additionally, it examines the association between patients' quality of life (QoL) and their out-of-pocket costs in both 2010 and 2021.

Annual updates of cost are critical to assess the financial value of antineoplastic drugs, given the significant changes in cancer treatment patterns and pricing over the previous decades. Since 2010, the drug pricing, insurance systems, and patient cost-sharing methods have changed, and current estimates are required for informing policy changes, guiding reimbursement methods, promoting value-based care approaches, and ensuring equitable access to medications.

Methods

Data Sources

This study was conducted using Medical Expenditures Panel Survey (MEPS) data, specifically the 2010 and 2021 full-year consolidated data files and full-year prescription drug files from the same years. The MEPS is a subsample of the National Health Survey, with its estimates being nationally representative of non-institutionalized adults living in the US. The National Center for Health Statistics and The Agency for Healthcare Research and Quality funded the research for MEPS data. The data includes a wide variety of information, including patient demographics, health expenditures, and anticancer usage.[14] MEPS is distinctive in that it links antineoplastic expenses with demographic factors and quality-of-life metrics, offering a holistic view of the patient experience that clinical or claims-only databases do not provide. Thus, integrating worldwide trends in cancer spending with U.S.-specific financial difficulties requires robust national data, and MEPS provides the required detail to assess both cost patterns and their implications for patients.

Ethical Approval

The Westat International Review Board reviews MEPS data annually. The Office for Protection from Research Risks granted and approved this process. The pharmacy component of the survey was administered by the Research Triangle Institute's International Review Board and the Office for Protection from Research Risks. All data used in this project are publicly available and do not require additional permission for access.[15] In addition, institutional ethical approval for conducting this analysis was obtained from the Institutional Review Board at Prince Sattam bin Abdulaziz University, Kingdom of Saudi Arabia (Protocol No. SCBR-546/2025).

Variable Definitions

All patients receiving antineoplastic agents were included in this study. The definition of treatment in the MEPS is based on the Multum Lexicon variables from Cerner Multum, Inc. Two main categories were considered: therapeutic class 1 and therapeutic subclasses. The antineoplastic class was coded as (20) and had multiple subcategories: alkylating agents (21), antimetabolites (23), antineoplastic hormones (24), miscellaneous antineoplastics (25), mitotic inhibitors (26), antineoplastic interferons (324), antineoplastic detoxifying agents (383), multikinase inhibitors (397), BCR-ABL tyrosine kinase inhibitors (398), cluster of differentiate 20 monoclonal antibodies (401), vascular endothelial growth factor and its receptor inhibitors (402), mammalian target of rapamycin inhibitors (403), epidermal growth factor receptor inhibitors (404), human epidermal growth factor receptor 2 inhibitors (405), proteasome inhibitors (454), and cyclin-dependent kinase 4/6 inhibitors (501).[5] All cancer subcategories are reported in Appendix A.

Medication use was identified as involving antineoplastic drugs prescribed by healthcare professionals and dispensed between 2010 and 2021. The years 2010 and 2021 were chosen to represent a decade of significant developments in

cancer therapies, insurance coverage, and healthcare expenses. Initial prescriptions and refills were included in expense and usage estimates. Household members first report these prescriptions, which are then validated by their pharmacists. Expenditures incorporated the sum of direct (out-of-pocket and third-party) payment sources to pharmacies for medications reported by patients in the MEPS. Out-of-pocket costs are all payments made by patients or their family members. Third-party payments are all payments by Medicare, Medicaid, private insurance, veterans' affairs, and other federal or state sources.[16] Moreover, an additional comparison was conducted between total medical prescription expenditures for cancer and non-cancer patients in 2010 and 2021. The later medicine expenditures accounted for all types of treatment expenditures for the years studied.

Cancer types were identified using the priority conditions variables in the MEPS consolidated data files. Patients first self-reported these conditions, which were then validated by healthcare providers' diagnoses. Only cancer types prevalent in both the 2010 data and 2021 files were reported. Patients might report multiple diagnoses with cancer. Other independent factors include age, sex, region, insurance coverage, and income level. Moreover, patients' deaths during the surveyed years were captured and reported in the analysis.

QoL comprises both physical and mental components. Each participant in the MEPS was asked 12 questions from the Short Form 12, Version 2. Then, the physical and mental scores were calculated by weighing them differently across these 12 questions. Questions related to pain and physical limitations weighed more in the physical score and ranged from 4 to 74. Emotion and well-being weighed more in the mental score, ranging from 6 to 74. The MEPS aggregate score was used for analysis.

Cost Adjustment

Costs in the MEPS are collected through multiple processes and validation. First, the household representative reports healthcare utilizations. Then, consent is taken to contact the affiliated healthcare institute involved. For prescription drugs, the pharmacy is contacted for the cost associated with the prescriptions. All costs involved were self-reported and then validated.

Expenditures in 2010 were adjusted to 2021 figures, accounting for inflation. Dollar adjustments were conducted using two methods: (1) out-of-pocket expenditure for 2010, adjusted based on the consumer price index, which yielded a factor of 1.24; and (2) third-party payers' estimates, adjusted using gross domestic product, which yielded a factor of 1.23. Another sensitivity analysis was conducted to adjust for the price using the price index for prescription drugs from the Bureau of Labor Statistics' Consumer Price Index, which resulted in a factor of 1.28. Both methods were recommended in MEPS documentation for using correct estimates for the United States, the GDP price index for overall health expenditures, and the CPI for out-of-pocket expenses. The results of the sensitivity analysis are reported in Appendix B.[16,17] This dual-method approach was used because the CPI more correctly reflects the inflation experienced by consumers for out-of-pocket costs, whilst the GDP index is a better indicator of overall inflation important to third-party payers.

Data Analysis

A series of explanatory analyses were conducted for the total expenditure, utilization, number of patients, and average out-of-pocket costs of antineoplastic agents. Chi-square tests were used to examine the distribution across categorical variables (age, sex, region, income level, and death) across 2010 and 2021, while Student's t-tests were utilized to compare means of continuous variables (expenditures and utilizations) across the two years. Four ordinal logistic regression models were employed to explore the association between physical and mental health status and out-of-pocket expenses, controlling patients' characteristics. All analyses accounted for MEPS stratification, clustering, and sampling complexity using techniques guided by The Agency for Healthcare Research and Quality and the National Center for Health Statistics. Missing expenditure values were handled using MEPS-provided imputed values consistent with AHRQ recommendations, and all ordinal logistic regression models met the proportional odds assumption, with effect sizes reported as odds ratios and corresponding 95% confidence intervals to facilitate interpretation. SAS Studio 3.81 (Enterprise Edition) was used for analysis, and Microsoft Excel was employed to plot figures and graphs. The statistical significance was determined at a p-value of less than 0.05.

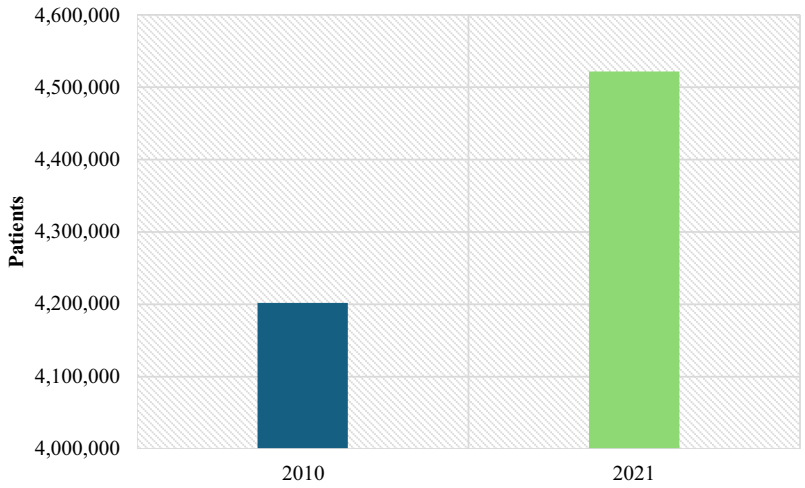

Figure 1 Number of patients receiving antineoplastic therapy, 2010 vs 2021. Weighted number of US patients receiving at least one antineoplastic agent in each year, based on MEPS national estimates. Values are presented as weighted frequencies (in millions).

Results

Patient Demographics and Utilization

In 2010, the US had an estimated 308,573,976 inhabitants, of whom 23,917,699 had reported cancer diagnoses during their lifetime. In 2021, the estimated US population was 331,249,393, with 28,810,768 people reporting cancer diagnoses. This reflects a 7.35% increase in population from 2010 to 2021 and a 20.46% rise in cancer diagnoses. From 2010 to 2021, the number of patients receiving antineoplastic therapy increased by 7.61%, from 4,201,932 (95% CI [4,186,569, 4,217,295]) to 4,521,745 (95% CI [4,497,515, 4,545,975]). However, the association was not statistically significant (t=0.31, p=0.57). Figure 1 compares antineoplastic utilization in 2010 and 2021.

Table 1 details patient usage by sex, age, region, income, and insurance status. A comparison of patient usage by sex revealed an increase in antineoplastic utilization by 71.18% for males and a decrease of 4.64% for females. Thus, the

Table 1 General Characteristics of Patients Using Antineoplastic Agents

Factor	2010	2021	p
	Weighted Frequency (%)	Weighted Frequency (%)	
Females	3,522,796 (83.84%)	3,359,211 (74.29%)	0.01
Average age (SE)	53.95 (1.23)	56.52 (1.50)	0.01
Regions			0.77
Northeast	678,485 (16.32%)	835,829 (18.76%)	
Midwest	831,515 (20.00%)	916,112 (20.56%)	
South	1,752,695 (42.16%)	1,666,409 (37.40%)	
West	894,376 (21.51%)	1,037,029 (23.28%)	
Income level			0.06
Poor	498,763 (11.88%)	629,140 (13.91%)	
Near poor	201,038 (4.78%)	168,193 (3.72%)	

(*Continued*)

Table 1 (Continued).

Factor	2010	2021	p
	Weighted Frequency (%)	Weighted Frequency (%)	
Low-income	568,939 (13.54%)	357,533 (7.91%)	
Middle-income	1,090,124 (25.94%)	1,073,224 (23.73%)	
High-income	1,843,067 (43.86%)	2,293,655 (50.72%)	
Insurance coverage			0.11
Any private	2,997,734 (71.34%)	2,926,515 (64.72%)	
Public only	1,038,794 (24.72%)	1,483,105 (32.80%)	
Uninsured	165,404 (3.94%)	112,125 (2.48%)	

Notes: Weighted frequencies were calculated to reflect the complexities of the MEPS national sampling design, accounting for strata and clustering.
Abbreviation: SE, standard error.

association between sex and year was significant at 0.01 $\chi 2(1, N=8,723,677)=11.01$, $p<0.01$. The average age of patients undergoing antineoplastic therapy in 2010 was 53.95 years, while the average age rose to 56.52 years in 2021. There was a significant difference in age between the two years, t=3.45, $p=0.01$. In the US, the highest increase in antineoplastic use was in the Northeast (14.95%), followed by the West (8.23%) and Midwest (2.80%), while the South showed a decline in usage from 2010 to 2021 by 11.29%. Regarding family income, patients with a low or negative income and high-income levels reported an increase in utilization from 2010 to 2021 of 25.97% and 24.50%, respectively. Meanwhile, near-poor, low-, and middle-income patients had decreased antineoplastic usage by 22.17%, 41.55%, and 8.51%, respectively. The associations between year, region, and income level were statistically insignificant. Examining utilization by insurance status revealed that between 2010 and 2021, the percentage of patients with private insurance decreased by 9.28%, the percentage of patients with public-only insurance rose by 32.66%, and the percentage of patients without insurance decreased by 37.06%. Additionally, an estimate of 15,363 patients died during the surveyed year in 2010, while 16,041 died in 2021. The association between years of treatment utilization and death was not statistically significant at 0.05.

Antineoplastic Expenditures

Antineoplastic expenditures rose dramatically, threefold, from $9.78 billion (95% CI [1587.65, 3094.73]) in 2010 to $35.12 billion (95% CI [5192.37, 10,340.06]) in 2021 (Figure 2). That increase was statistically significant t=4.01, $p<0.01$. Out-of-pocket costs increased by 94.84%, from $743,575,354 95% CI [150.92, 203.42]) in 2010 to $1,449,451,253 (95% CI [158.54, 482.57]) in 2021. This increase was statistically significant t=1.83, $p<0.01$. Concurrently, the third-party costs rose by 272.48%, from $9,038,756,876 (95% CI [1416.36, 2912.69]) in 2010 to $33,667,377,898 (95% CI [4937.64, 9953.68]) in 2021 (Figure 3). This increase in third-party costs was statistically significant t=4.37, $p<0.01$. The number of antineoplastic prescriptions was comparable between 2010 and 2021 (19,766,772 (95% CI: [17.77 million, 21.71 million]) and 20,607,324 (95% CI: [18.65 million, 22.57 million]), respectively), averaging four prescriptions per year for patients. Accordingly, the association was not statistically significant, at $p=0.75$ (Figure 4).

Table 2 describes the most reported cancer diagnoses in 2010 and 2021. The most prevalent cancer diagnosis in both years was breast cancer. From 2010 to 2021, prostate cancer and skin nonmelanoma showed increases of 62.5% and 114.7%, respectively. Concurrently, bladder and lung cancers showed declines of 84.1% and 40.3%, respectively.

A comparison of the expenditures of all prescribed medicines for patients with cancer versus other populations in 2010 and 2021 was conducted. In 2010, the average annual cost of all medicine for cancer patients was $5594, while non-cancer patients paid an average of $1017. In contrast, in 2021, the average annual prescribed medicine expenditure was $12,985 for cancer patients and $1421 for non-cancer patients.

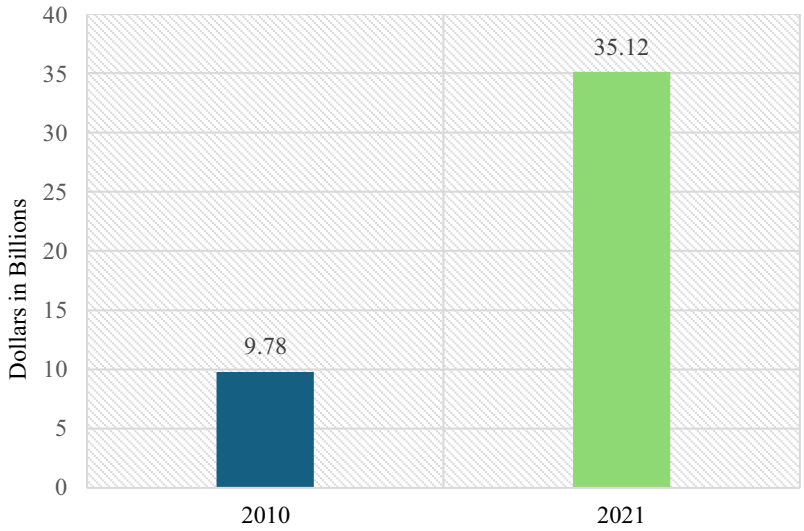

Figure 2 Total annual expenditures on antineoplastic agents, 2010 vs 2021. Total expenditures for antineoplastic medications, expressed in 2021 US dollars, including all payer sources (Medicare, Medicaid, private insurance, out-of-pocket, and other federal/state programs). Costs are reported in billions.

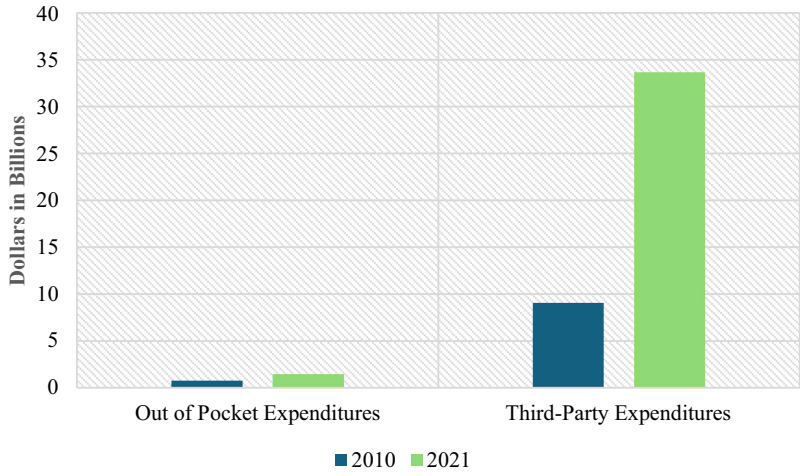

Figure 3 Out-of-pocket spending and third-party payer contributions for antineoplastic agents, 2010 vs 2021. Distribution of antineoplastic drug payments by payer type, including out-of-pocket spending and third-party payers (Medicare, Medicaid, private insurance, and other government sources). Dollar amounts are presented in 2021 US dollars.

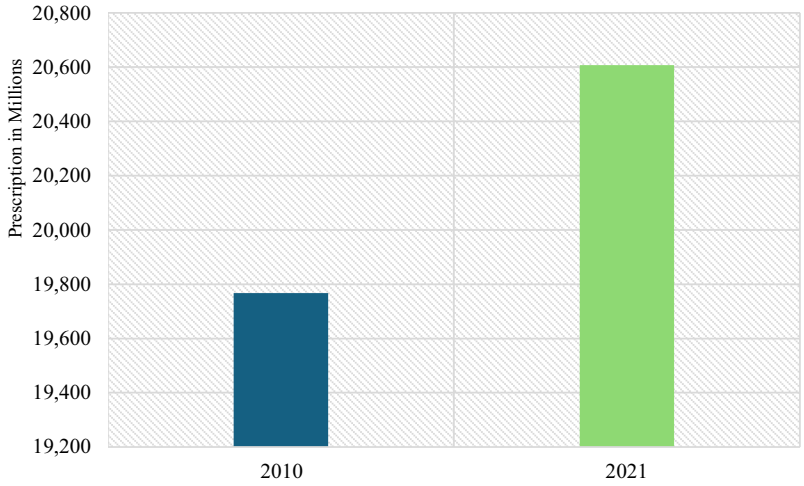

Figure 4 Utilization rates for antineoplastic agents, 2010 vs 2021. Proportion of the US population receiving antineoplastic therapy in each year, presented as prescriptions per year for patients.

Table 2 Frequencies of Most Common Cancer Types in 2010 and 2021

Cancer Types	2010	2021
	Weighted Frequency	Weighted Frequency
Bladder	46,775	7424
Breast	1,094,816	1,030,500
Cervix	29,550	29,468
Colon	60,987	71,493
Lung	136,477	81,430
Lymphoma	8414	30,184
Melanoma	53,014	75,476
Prostate	115,355	186,873
Skin-Nonmelanoma	77,654	166,512
Uterus	19,257	25,972

Notes: Weighted frequencies were calculated to reflect the complexities of the MEPS national sampling design, accounting for strata and clustering.

Table 3 Association Between QoL Components and Out-of-Pocket Costs

Factor	Health-Related QoL							
	2010				2021			
	Physical		Mental		Physical		Mental	
Out-of-pocket expenditures	0.04	0.7	0.009	0.5	0.004	0.07	0.002	0.2

Notes: Controlling for age, sex, region, and income level. The values represent physical or mental QoL scores and *p*-values.
Abbreviation: QoL, quality of life.

The Association Between Cancer Drug Costs and Patients' QoL

The final analysis explored the association between patients' QoL using antineoplastic agents and their out-of-pocket expenditures in 2010 and 2021. Four ordinal logistic regression models were used. There was no significant association between the physical or mental QoL scores and out-of-pocket costs (Table 3).

Discussion

Expenditures and Utilization

This study aimed to describe the expenditures and use of antineoplastic agents between 2010 and 2021. In terms of expenditures, the price of antineoplastic drugs grew threefold over approximately ten years. Most payments were made by Medicare, Medicaid, private insurance, veterans' affairs, and other federal or state sources. These figures highlight concerns about cancer care, particularly in terms of affordability and accessibility. Furthermore, the results emphasize the importance of the new payment model proposed by the US Centers for Medicare & Medicaid Services for antineoplastic agents, which aims to replace the fee-for-service payment method.[18] Several reasons might explain the price increase, including significant pharmaceutical innovations in antineoplastic agents over the past decade compared to other medical conditions.[19] Other important factors include rising healthcare costs in general, advancements in diagnosis and monitoring, and the nature of cancer, which may require personalized medicine.[20]

Another important finding is that the use of antineoplastic drugs had modest growth compared with expenditures between 2010 and 2021. Focusing on the demographic changes associated with increased pricing and steady usage may explain this issue. The average age and proportion of males using antineoplastic agents rose during the study period. Generally, there is a positive association between healthcare costs and age.[21] The reduced proportion of female patients receiving antineoplastic therapy may represent shifts in cancer epidemiology or treatment patterns over time; however, this interpretation is speculative and should be examined in disease-specific analyses, such as breast cancer trends. However, access to breast cancer treatment remains an issue worldwide.[22] Further research is required to detail the contribution of cancer patients' demographics to the growing cancer costs and highlight potential disparities in cancer care.

Impact of Antineoplastic Treatment on Survivor QOL and Life Expectancy

There is general disagreement in the literature regarding whether antineoplastic treatment extends the life expectancy of cancer survivors. On the one hand, reported decreased life expectancy is associated with children with cancer using chemotherapy and radiotherapy. On the other hand, The American Cancer Society has shown that antineoplastic agents expands life expectancy for survivors.[23,24] Although the average age of patients receiving antineoplastic medicines increased by three years, this pattern should be evaluated carefully, because MEPS data cannot clarify whether this reflects increasing life expectancy, cohort effects, or changes in treatment eligibility. Moreover, the focus should not only be on the number of years of life antineoplastic treatment offers but also the enhanced QoL gained by patients.

International agencies have various methods of evaluating treatment. China has adapted technology to reduce the financial burden associated with travel and the accessibility of healthcare in rural areas. This technology covers over 3000 hospitals, offering remote consultations for underserved communities.[25] Additionally, India's National Cancer Program has collaborated with the private sector to help improve the country's infrastructure and subsidize treatment options. These efforts transformed primary healthcare services into wellness centers, expanding cancer care and offering medications for vulnerable families.[26] Both methods differ from those used in the United States. However, through these efforts, countries in Asia and Europe have demonstrated an increase in total health expenditures per capita for cancer care compared to North American countries.[27]

Furthermore, the results emphasize the potential role that healthcare providers can play beyond providing clinical services for chronic diseases in general and antineoplastic agents in particular.[28] This study found that out-of-pocket expenses did not have an impact on the mental or physical aspects of QoL. However, it is important to note that this study was limited by the nature of the data. In the future, healthcare providers could take the opportunity to assess the QoL of cancer patients in order to investigate factors that affect the quality of cancer services.

Limitations

This study has various limitations due to the data source. First, MEPS is based on self-reported data for conditions, medications, and expenditures, which may be vulnerable to recall bias. MEPS addresses this by confirming household reports with pharmacies and medical providers. Second, because the survey excluded institutionalized populations (eg, those in nursing homes or prisons), our findings may not represent all US adults and may underestimate the burden and cost of cancer in these vulnerable groups. Finally, while MEPS is a strong, nationally representative survey of the non-institutionalized population, its complicated design was factored into all analyses as suggested.[13]

The lack of significant associations between out-of-pocket expenses and QoL may reflect the limitations of MEPS data, including self-reported expenditures, broad cancer categories, and unmeasured factors such as symptom burden, stage, or treatment intensity. It is also possible that financial strain is mediated through psychosocial pathways not fully captured by the SF-12, leading to attenuated regression estimates.

Future Perspectives

In recent years, the introduction of immunotherapy has had positive clinical outcomes for patients with cancer, particularly those with rare cancers.[29,30] These immunotherapies are expected to play a significant role in cancer treatment through unique mechanisms, including immune checkpoint blockades, adoptive cell therapy, cancer vaccines,

and cytokine therapy.[29] However, these treatments have increased the economic burden on healthcare systems.[31] The results highlight a number of policy issues. The necessity for value-based reimbursement strategies that take therapeutic benefit, patient experience, and equity into consideration is highlighted by rising prescription costs without corresponding increases in utilization.[9,32] Growing reliance on public insurance reinforces the importance of Medicare and Medicaid in maintaining access to essential cancer therapies. The QoL findings, while descriptive, support integrating routine QoL assessment into oncology care to better identify patients at risk for psychosocial distress or unmet supportive-care needs. Additionally, improved price-negotiation strategies and more comprehensive evidence frameworks that include non-traditional aspects of value, such as hope, productivity, and caregiver impact, are necessary due to the growing costs of immunotherapy and targeted medicines.[31–34]

Conclusion

The rise in antineoplastic expenditures in the United States between 2010 and 2021, without a proportional increase in utilization, highlight the growing financial burden associated with cancer treatment. This growing gap stresses the affordability and equitability for current cancer treatment. These findings reinforce the need for policies that ensure patients can benefit from advances in cancer therapy without facing disproportionate financial strain.

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Disclosure

There is nothing to declare. This study analyzes de-identified data from the publicly available Medical Expenditure Panel Survey (MEPS), collected under strict confidentiality protections per the Public Health Service Act and HIPAA.

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