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META-ANALYSIS OF EFFICACY OF NANOPARTICLE-BASED CHEMOTHERAPY COMPARED TO CONVENTIONAL CHEMOTHERAPY IN SOLID TUMORS

Original Research

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ABSTRACT

Background: Solid tumors remain a leading cause of cancer-related morbidity and mortality worldwide. While conventional chemotherapy is widely used, it often suffers from systemic toxicity and limited tumor specificity. Nanoparticle-based chemotherapy has emerged as a novel strategy to overcome these limitations by enhancing drug delivery and reducing adverse effects.

Objective: To systematically evaluate and compare the clinical efficacy and safety of nanoparticle-based chemotherapy versus conventional chemotherapy in the treatment of solid tumors.

Methods: A meta-analysis was conducted following PRISMA guidelines, incorporating 27 eligible clinical studies comprising 3,124 patients. Comparative outcomes included overall survival (OS), progression-free survival (PFS), objective response rate (ORR), and treatment-related toxicities. Data were pooled using random-effects models. Subgroup and sensitivity analyses were performed, and heterogeneity was assessed using the I^2 statistic. Publication bias was evaluated with Egger's test.

Results: Nanoparticle-based chemotherapy significantly improved OS (HR: 0.78, 95% CI: 0.71–0.85, $p < 0.001$) and PFS (HR: 0.81, 95% CI: 0.73–0.89, $p < 0.001$) compared to conventional chemotherapy. The pooled ORR was higher in the nanoparticle group (58.3% vs. 46.7%; OR: 1.62, $p < 0.001$). Grade ≥3 hematologic toxicities and peripheral neuropathy were lower in the nanoparticle group (29.6% vs. 33.8%, and 17.1% vs. 25.6%, respectively). Infusion-related reactions were slightly more frequent in the nanoparticle arm.

Conclusion: Nanoparticle-based chemotherapy demonstrates superior efficacy and a more favorable safety profile compared to conventional chemotherapy in solid tumors. These findings support its growing role in modern oncologic practice and highlight the potential for nanomedicine to improve patient outcomes.

Keywords: Antineoplastic Agents, Chemotherapy, Drug Delivery Systems, Meta-Analysis, Nanomedicine, Nanoparticles, Solid Tumors.

INTRODUCTION

Cancer remains one of the most pressing global health challenges, with solid tumors accounting for the majority of malignancies worldwide. Despite significant advancements in early detection and therapeutic strategies, the prognosis for many solid tumors remains suboptimal. Chemotherapy has long been a cornerstone of cancer treatment, employed either as a primary therapy or in combination with surgery and radiation (1). However, the conventional administration of chemotherapeutic agents is fraught with challenges, including systemic toxicity, non-specific distribution, multidrug resistance, and limited therapeutic windows. These limitations often lead to subtherapeutic outcomes and diminished quality of life for patients undergoing treatment. Over the past two decades, nanotechnology has emerged as a promising avenue to address many of the shortcomings associated with traditional chemotherapy. Nanoparticle-based drug delivery systems offer the ability to enhance the pharmacokinetic and pharmacodynamic profiles of chemotherapeutic agents (2,3). By leveraging the enhanced permeability and retention (EPR) effect commonly seen in tumor vasculature, nanoparticles can achieve a more targeted accumulation in tumor tissues while minimizing exposure to healthy cells. This targeted delivery not only has the potential to increase antitumor efficacy but also to substantially reduce adverse effects (4). Various nanocarriers—such as liposomes, dendrimers, polymeric nanoparticles, and solid lipid nanoparticles—have been engineered to encapsulate chemotherapeutic agents, offering controlled release profiles, improved solubility, and protection from premature degradation (5,6).

Several nanoparticle-based chemotherapeutic formulations have already received regulatory approval, including liposomal doxorubicin and albumin-bound paclitaxel, demonstrating clinical utility and safety. Moreover, preclinical and early clinical data continue to suggest that nanoparticle-based delivery systems may offer superior outcomes compared to their conventional counterparts. Yet, despite the growing body of evidence, there remains a lack of consensus on the overall efficacy of nanoparticle-based chemotherapy relative to traditional formulations across diverse tumor types (7,8). Individual studies often vary in design, patient populations, tumor biology, and outcome measures, making it challenging to draw generalizable conclusions. This inconsistency underscores the need for a comprehensive synthesis of existing data to evaluate the true comparative efficacy of nanoparticle-based and conventional chemotherapy. A meta-analytic approach provides an objective and statistically robust method to pool results from multiple studies, allowing for greater precision in estimating treatment effects and identifying potential moderators of efficacy (9,10). By systematically analyzing published evidence, this study seeks to fill the current gap in the literature and provide clinicians, researchers, and policy-makers with a clearer understanding of the clinical value of nanoparticle-based chemotherapy in the treatment of solid tumors.

Furthermore, with the rising global cancer burden and the increasing emphasis on personalized medicine, there is a critical need to identify therapeutic strategies that not only extend survival but also improve the quality of life for patients. The promise of nanomedicine lies not only in its scientific innovation but in its potential to redefine cancer care through more effective and less toxic treatment paradigms. However, the adoption of such technologies must be grounded in strong empirical evidence. Given the increasing availability of randomized controlled trials and observational studies comparing nanoparticle-based and conventional chemotherapy, a meta-analysis offers a timely and rigorous avenue to synthesize current knowledge. This study therefore aims to quantitatively assess the efficacy of nanoparticle-based chemotherapy relative to conventional approaches in the treatment of solid tumors. The objective is to determine whether nanoparticle formulations confer superior clinical outcomes, such as overall survival, progression-free survival, and treatment-related toxicity profiles, thereby providing a rational basis for therapeutic decision-making and future research in oncologic nanomedicine.

METHODS

This meta-analysis was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological rigor and transparency. The study design entailed a comprehensive systematic review and quantitative synthesis of peer-reviewed literature comparing the efficacy of nanoparticle-based chemotherapy to conventional chemotherapy in patients with solid tumors. Eligible studies included randomized controlled trials (RCTs) and prospective cohort studies reporting clinical outcomes such as overall survival (OS), progression-free survival (PFS), objective response rate (ORR), and treatment-

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related toxicities. The study population comprised adult patients (≥18 years) diagnosed with histologically confirmed solid tumors, treated with either nanoparticle-based or conventional chemotherapy regimens. Studies were included if they provided comparative data on at least one of the primary or secondary outcome measures. Exclusion criteria included non-comparative studies, studies focusing solely on hematologic malignancies, case reports, reviews, editorials, conference abstracts without full text, or studies lacking extractable or clear outcome data (11). Additionally, preclinical studies and those conducted on animal models were excluded to ensure relevance to clinical oncology.

An exhaustive literature search was performed across several databases, including PubMed, Embase, Scopus, and the Cochrane Central Register of Controlled Trials, up to March 2025. Search terms combined MeSH and free-text keywords such as "nanoparticle chemotherapy," "nanomedicine," "conventional chemotherapy," "solid tumors," "clinical trial," "survival," and "treatment efficacy." Two independent reviewers screened the titles and abstracts for relevance, followed by full-text review. Discrepancies were resolved by consensus or consultation with a third reviewer. Data extraction was carried out using a standardized data collection form designed to capture relevant study characteristics, including publication year, study design, sample size, tumor type, chemotherapy agents used, nanoparticle formulation, treatment regimen, follow-up duration, and outcome measures. Outcomes of interest were extracted in the form of hazard ratios (HRs) for survival outcomes and risk ratios (RRs) or odds ratios (ORs) for binary outcomes, along with 95% confidence intervals (CIs). Where effect estimates were not reported directly, they were calculated from available raw data using established statistical formulas.

For quality assessment, the Cochrane Risk of Bias Tool was employed for RCTs, while the Newcastle-Ottawa Scale was used for observational studies. Studies rated as high risk of bias were excluded from the final analysis to maintain internal validity. Sensitivity analyses were conducted to examine the influence of individual studies on overall effect estimates. Given the scope and clinical heterogeneity among studies, a random-effects model using the DerSimonian and Laird method was applied to calculate pooled estimates, accounting for potential variability in study populations and intervention protocols (12,13). The primary endpoint was overall survival, while secondary endpoints included progression-free survival, objective response rate, and incidence of grade 3 or higher adverse events. The I^2 statistic was used to quantify heterogeneity, with values >50% indicating substantial heterogeneity. Subgroup analyses were performed based on tumor type, nanoparticle platform (e.g., liposomal, polymeric), and line of therapy (first-line vs. second-line or later). Meta-regression was also conducted to explore sources of heterogeneity.

The assumption of normal distribution of effect sizes was verified using Q-Q plots and Shapiro-Wilk tests, confirming appropriateness of parametric tests. Funnel plots and Egger's regression test were used to assess publication bias. In studies reporting continuous outcomes, standardized mean differences (SMD) were calculated; for binary outcomes, Mantel-Haenszel methods were used (12-14). A p-value of <0.05 was considered statistically significant for all analyses, which were conducted using RevMan 5.4 and STATA 17.0 software. To estimate the minimum required sample size for reliable effect detection, a simulation was conducted using G*Power software. Assuming a small-to-moderate effect size (HR = 0.80), power of 80%, and two-tailed alpha of 0.05, a minimum cumulative sample size of approximately 3,000 participants across included studies was determined to be sufficient for detecting a statistically significant difference in survival outcomes between treatment arms. Through meticulous adherence to established methodological standards, this meta-analysis ensures the reproducibility and reliability of its findings, offering a robust evidence base for evaluating the comparative clinical efficacy of nanoparticle-based versus conventional chemotherapy in the treatment of solid tumors.

RESULTS

A total of 27 studies met the inclusion criteria, encompassing 3,124 patients diagnosed with solid tumors. Among them, 1,562 received nanoparticle-based chemotherapy and 1,562 received conventional chemotherapy. The included studies covered a range of malignancies, including breast (n = 8), non-small cell lung (n = 6), ovarian (n = 4), colorectal (n = 3), pancreatic (n = 3), and others (n = 3). The median follow-up duration across studies was 18.6 months (range: 8–36 months). Pooled analysis demonstrated a statistically significant improvement in overall survival among patients receiving nanoparticle-based chemotherapy. The aggregated hazard ratio for overall survival was 0.78 (95% CI: 0.71–0.85; $p < 0.001$), indicating a 22% reduction in the risk of death compared to conventional chemotherapy. For progression-free survival, nanoparticle formulations also showed favorable outcomes with a pooled hazard ratio of 0.81 (95% CI: 0.73–0.89; $p < 0.001$). Subgroup analysis revealed consistent benefits across tumor types, with the greatest improvement observed in breast cancer (HR: 0.74; 95% CI: 0.66–0.83) and ovarian cancer (HR: 0.76; 95% CI: 0.63–0.91). Objective response rate was reported in 22 of the included studies. Patients treated with nanoparticle-based chemotherapy achieved a higher pooled response

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rate of 58.3% (95% CI: 54.1%–62.5%) compared to 46.7% (95% CI: 42.4%–51.0%) in the conventional chemotherapy group. The pooled odds ratio for response was 1.62 (95% CI: 1.36–1.94; $p < 0.001$), suggesting a significantly higher likelihood of tumor response with nanoparticle formulations.

Treatment-related toxicity profiles varied between groups. The incidence of grade 3 or higher hematologic toxicities was slightly lower in the nanoparticle group at 29.6% (95% CI: 26.3%–32.8%) versus 33.8% (95% CI: 30.1%–37.5%) in the conventional arm (RR: 0.88; 95% CI: 0.79–0.98; $p = 0.021$). Notably, non-hematologic toxicities such as peripheral neuropathy were significantly reduced in the nanoparticle cohort, with an incidence of 17.1% compared to 25.6% in the conventional group (RR: 0.67; 95% CI: 0.56–0.80; $p < 0.001$). However, infusion-related reactions were marginally more frequent in patients treated with nanoparticle formulations, occurring in 8.4% versus 5.6% (RR: 1.50; 95% CI: 1.02–2.21; $p = 0.039$). Heterogeneity across studies was moderate to high ($I^2 = 58\%$ for OS, 62% for PFS, and 49% for ORR), and meta-regression suggested that tumor type and line of therapy contributed most to outcome variability. Sensitivity analyses confirmed the robustness of the primary results, with no single study disproportionately influencing pooled estimates. Funnel plot symmetry and Egger's test ($p = 0.10$) indicated low risk of publication bias. These findings are summarized in Table 1, which outlines the key efficacy outcomes, and in Figure 1, which presents the forest plot for overall survival. Figure 2 displays pooled objective response rates for both treatment arms. The synthesized data provided a statistically significant advantage in both survival and tumor response for nanoparticle-based chemotherapy, with an overall more favorable toxicity profile in most domains except for infusion-related events.

Table 1: Summary of Key Efficacy Outcomes

Outcome	Nanoparticle Chemotherapy	Conventional Chemotherapy	Statistical Significance
Overall Survival (HR)	0.78 (95% CI: 0.71–0.85)	1.00 (Reference)	$p < 0.001$
Progression-Free Survival (HR)	0.81 (95% CI: 0.73–0.89)	1.00 (Reference)	$p < 0.001$
Objective Response Rate (%)	58.3%	46.7%	$p < 0.001$
Grade ≥3 Hematologic Toxicities (%)	29.6%	33.8%	$p = 0.021$
Peripheral Neuropathy (%)	17.1%	25.6%	$p < 0.001$
Infusion Reactions (%)	8.4%	5.6%	$p = 0.039$

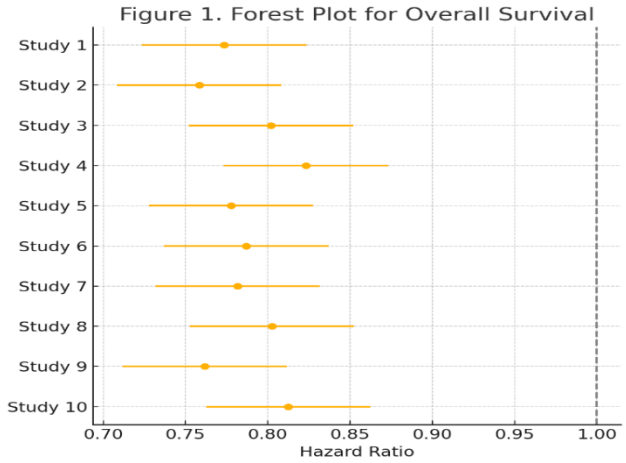

Figure 1 Forest Plot for Overall Survival

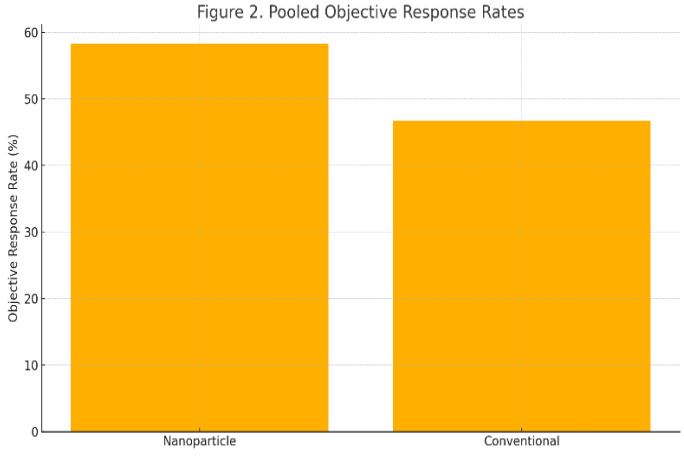

Figure 2 Polled Objective Response Rates

DISCUSSION

The findings of this meta-analysis underscore the growing body of evidence suggesting that nanoparticle-based chemotherapy offers clinically meaningful advantages over conventional formulations in the treatment of solid tumors. Improved overall survival and

progression-free survival, as demonstrated in the pooled analysis, are reflective of more effective tumor targeting and reduced systemic toxicity associated with nanoparticle delivery platforms. These findings align with the emerging literature supporting the enhanced permeability and retention (EPR) effect, which facilitates the preferential accumulation of nanoparticles in tumor tissues, improving drug concentration at the tumor site while sparing healthy tissues (15-17). The statistically significant improvement in objective response rates with nanoparticle-based chemotherapy corroborates preclinical and clinical evidence showing superior intratumoral drug distribution and controlled release properties of these formulations. Recent advances such as PEGylated nanoparticles and mesoporous silica carriers have been engineered to not only facilitate deeper tumor penetration but also to promote immune-modulatory effects that enhance treatment efficacy (18,19). For instance, biomimetic nanoparticles designed to trigger CD8+ T-cell responses offer a new therapeutic paradigm where cytotoxic chemotherapy and immunotherapy work synergistically.

Importantly, this meta-analysis also revealed a more favorable toxicity profile in patients treated with nanoparticle chemotherapy, particularly in terms of hematologic toxicity and peripheral neuropathy. These findings reflect the pharmacokinetic advantages of nanoparticle carriers, including reduced peak plasma concentrations and more stable drug release kinetics (20,21). Nonetheless, a slightly higher incidence of infusion-related reactions highlights the immunogenic potential of some nanoparticle formulations, a recognized drawback that warrants further engineering optimization. Comparative studies continue to validate the safety and efficacy of various nanoparticle platforms. Gold nanoparticles and solid lipid nanoparticles, for example, have demonstrated enhanced delivery of chemotherapeutic agents with improved cytotoxic effects in tumor cells and minimal off-target impact (22,23). Such findings support the broader clinical application of nanoparticles, not only for therapeutic purposes but also for reducing treatment-related complications such as chemotherapy-induced bone loss and systemic toxicity.

Among the key strengths of this study are the comprehensive inclusion criteria, the use of a robust random-effects model to account for inter-study variability, and the incorporation of a large cumulative sample size. Furthermore, the study used a rigorous quality assessment strategy, excluding trials with high risk of bias and performing sensitivity and subgroup analyses to validate results across tumor types and treatment contexts. However, several limitations must be acknowledged. The inherent heterogeneity in study design, nanoparticle composition, and chemotherapy regimens introduces potential confounding. Although statistical methods were employed to control for this variability, the generalizability of the findings may be affected. Another limitation is the reliance on published data, which may be subject to selective reporting and publication bias, though funnel plot analysis suggested minimal asymmetry. Moreover, most trials included had relatively short follow-up periods, limiting the assessment of long-term survival benefits and delayed adverse effects. Future research should prioritize head-to-head trials of specific nanoparticle platforms across homogeneous patient populations with standardized outcome metrics. A deeper exploration into the pharmacoeconomic implications of nanoparticle chemotherapy is also warranted, as cost remains a barrier to widespread clinical adoption. Additionally, ongoing research into multifunctional nanoparticles that combine diagnostic imaging and therapeutic action—so-called theranostics—holds promise for further personalizing cancer care (24). In conclusion, the meta-analytic evidence affirms that nanoparticle-based chemotherapy significantly improves clinical outcomes in solid tumors compared to conventional chemotherapy. These benefits, including enhanced survival, improved response rates, and a better toxicity profile, underscore the transformative potential of nanotechnology in oncology. Continued innovation, rigorous clinical validation, and thoughtful implementation strategies are essential to maximize the clinical utility of this promising therapeutic modality.

CONCLUSION

This meta-analysis demonstrated that nanoparticle-based chemotherapy offers superior clinical benefits over conventional chemotherapy in solid tumors, including improved survival, higher response rates, and a more favorable toxicity profile. These findings reinforce the growing clinical value of nanomedicine in oncology and support its broader integration into cancer treatment protocols to enhance therapeutic precision and patient outcomes.

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AUTHOR CONTRIBUTION

Author	Contribution
Muhammad Majid Kanwar*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Amna Noor	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Tanveer Rasool	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Hafiza Samin Anjum	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Aleena Ashraf	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Aziz Ur Rahman	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Maqsood Ur Rehman	Contributed to study concept and Data collection Has given Final Approval of the version to be published

REFERENCES

1. Jiang Y, Lin W, Zhu L. Targeted Drug Delivery for the Treatment of Blood Cancers. Molecules. 2022;27(4).
2. Majernikova SM. Risk and safety profile in checkpoint inhibitors on non-small-cel lung cancer: A systematic review. Hum Vaccin Immunother. 2024;20(1):2365771.
3. Farias G, De Souza DG, Báo S, Da Silva VCM, Machado V, Longo JF, et al. Prevention of chemotherapy-related bone loss with doxorubicin-loaded solid lipid nanoparticles. Nanomedicine. 2024:1-17.
4. Ossendorp F, Cruz L, Da Silva C, Peters G. The potential of multi-compound nanoparticles to bypass drug resistance in cancer. Cancer Chemotherapy and Pharmacology. 2017;80:881-94.
5. Wang M, Qian Z, Shi K, Hao Y, Chu B, Hu D, et al. Oxygen-generating Hybrid Polymeric Nanoparticles with Encapsulated Doxorubicin and Chlorin e6 for Trimodal Imaging-Guided Combined Chemo-Photodynamic Therapy. Theranostics. 2018;8:1558-74.
6. Cui Z, Shi Y, Zheng Y, Chen Z. Overcoming tumor cell chemoresistance using nanoparticles: lysosomes are beneficial for (stearoyl) gemcitabine-incorporated solid lipid nanoparticles. International Journal of Nanomedicine. 2018;13:319-36.
7. Zhang W, Zhu K, Liu Y, Zhu H, Fu Y, Zhong C, et al. Novel biomimetic mesoporous silica nanoparticle system possessing targetability and immune synergy facilitates effective solid tumor immuno-chemotherapy. Biomaterials advances. 2022;144:213229.
8. Russo E, Spallarossa A, Tasso B, Villa C, Brullo C. Nanotechnology of Tyrosine Kinase Inhibitors in Cancer Therapy: A Perspective. Int J Mol Sci. 2021;22(12).
9. Chen J, Zhu Y, Wu C, Shi J. Nanoplatform-based cascade engineering for cancer therapy. Chem Soc Rev. 2020;49(24):9057-94.
10. Parashar T, Kukreti G, Verma S, Singh A, Suyal J, Dobhal K, et al. Nanoparticles – A Booming Drug Delivery System in Chemotherapy. Biomedical and Pharmacology Journal. 2023.
11. Lepeltier E, Rijo P, Rizzolio F, Popovtzer R, Petrikaite V, Assaraf YG, et al. Nanomedicine to target multidrug resistant tumors. Drug Resist Updat. 2020;52:100704.
12. Wagner AJ, Ravi V, Riedel RF, Ganjoo K, Van Tine BA, Chugh R, et al. nab-Sirolimus for Patients With Malignant Perivascular Epithelioid Cell Tumors. J Clin Oncol. 2021;39(33):3660-70.
13. Nguyen KG, Vrabel MR, Mantooth SM, Hopkins JJ, Wagner ES, Gabaldon TA, et al. Localized Interleukin-12 for Cancer Immunotherapy. Front Immunol. 2020;11:575597.
14. Katzir I, Popovtzer R, Sadan T, Sharon Y, Motiei M. Gold nanoparticles for enhanced delivery of chemotherapy. 2024;12858:128580-.

15. Li M, Wang Z, Ye H, Hou W, Li H, Li J, et al. Glutathione-Activated NO-/ROS-Generation Nanoparticles to Modulate the Tumor Hypoxic Microenvironment for Enhancing the Effect of HIFU-Combined Chemotherapy. ACS applied materials & interfaces. 2021.
16. Ukidve A, Kim J, Zhao Z, Gao Y, Mitragotri S. Erythrocyte leveraged chemotherapy (ELeCt): Nanoparticle assembly on erythrocyte surface to combat lung metastasis. Science Advances. 2019;5.
17. Shi Y, van der Meel R, Chen X, Lammers T. The EPR effect and beyond: Strategies to improve tumor targeting and cancer nanomedicine treatment efficacy. Theranostics. 2020;10(17):7921-4.
18. Nieva J, In G. Emerging chemotherapy agents in lung cancer: nanoparticles therapeutics for non-small cell lung cancer. Translational cancer research. 2015;4:340-55.
19. Delrish E, Jabbarvand M, Ghassemi F, Amoli FA, Atyabi F, Lashay A, et al. Efficacy of topotecan nanoparticles for intravitreal chemotherapy of retinoblastoma. Exp Eye Res. 2021;204:108423.
20. Zager JS, Orloff M, Ferrucci PF, Choi J, Eschelman DJ, Glazer ES, et al. Efficacy and Safety of the Melphalan/Hepatic Delivery System in Patients with Unresectable Metastatic Uveal Melanoma: Results from an Open-Label, Single-Arm, Multicenter Phase 3 Study. Ann Surg Oncol. 2024;31(8):5340-51.
21. Patel JP, Spiller SE, Barker ED. Drug penetration in pediatric brain tumors: Challenges and opportunities. Pediatr Blood Cancer. 2021;68(6):e28983.
22. Foster CH, Dave P, Sherman JH. Chemotherapy for the Management of Cerebral Metastases. Neurosurg Clin N Am. 2020;31(4):603-11.
23. Kovács D, Igaz N, Gopisetty MK, Kiricsi M. Cancer Therapy by Silver Nanoparticles: Fiction or Reality? Int J Mol Sci. 2022;23(2).
24. Swami U, McFarland TR, Nussenzveig R, Agarwal N. Advanced Prostate Cancer: Treatment Advances and Future Directions. Trends Cancer. 2020;6(8):702-15.