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# A Study on the Impact of Nanotechnology in Drug Delivery Systems: Innovations in Cancer Treatment

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**ABSTRACT:**

The integration of nanotechnology into drug delivery systems represents a paradigm shift in oncology, offering unprecedented opportunities to enhance therapeutic efficacy while minimizing systemic toxicity. This study conducts a comprehensive quantitative analysis of nanocarrier-based drug delivery systems (DDS) for cancer treatment, evaluating their clinical impact, technological innovations, and translational challenges. Employing a problem-based research methodology, the investigation synthesizes data from clinical trials (2005-2023), preclinical studies, and market analyses, focusing on four principal nanocarrier platforms: liposomes, polymeric nanoparticles, dendrimers, and inorganic nanoparticles. Results demonstrate that nano-enabled drug delivery enhances tumor accumulation by 10-100 fold through enhanced permeability and retention (EPR) effects and active targeting, with median drug concentrations in tumor tissue reaching 5-8% of injected dose compared to 0.1-0.5% for conventional chemotherapy. Clinical outcomes show significant improvements: nanoparticle albumin-bound paclitaxel (nab-paclitaxel) increased response rates in metastatic breast cancer by 33% compared to solvent-based paclitaxel, while reducing neurotoxicity incidence by 28%. However, translation remains challenging, with only 8.7% of nanomedicine candidates progressing from Phase I to FDA approval. Critical barriers identified include batch-to-batch variability (coefficient of variation >15% for 42% of formulations), scale-up complexities, and immunological recognition leading to accelerated blood clearance. Economic analysis reveals that nanomedicines command a 3-8x price premium over conventional counterparts, though value-based assessments show improved cost-effectiveness in specific indications. Emerging innovations—particularly stimuli-responsive "smart" nanoparticles and combination immunotherapy platforms—demonstrate potential to overcome current limitations. This research concludes that nanotechnology fundamentally enhances cancer pharmacotherapy, but realizing its full potential requires addressing manufacturing standardization, regulatory harmonization, and healthcare system integration challenges within a patient-centered framework.

***Keywords:*** *Nanotechnology, Drug Delivery Systems, Cancer Therapy, Nanomedicine, Targeted Therapy, Nanoparticles, Translational Research*

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## INTRODUCTION

Cancer has remained among the most common causes of mortality in all parts of the world since it can be non-selectively biodistributed, it is overly systemic, and it acquires multidrug resistance (Siegel, Miller, and Jemal, 2020). The nanotechnology of drug delivery has offered a breakthrough in overcoming these restrictions by the engineered systems which also enhance the tumour targeting, control of Pharmacokinetics, and circumvention of the biological barriers (Peer et al., 2007). Nanocarriers which are particles with dimensions ranging between 1-1000 nm radically change the therapeutic index of anticancer drugs. They modify the solubility and the circular time of the drug and the cellular uptake by having special physicochemical properties (Davis, Chen, and Shin, 2008). Thanks to the past 20 years, nanomedicine has evolved to become a clinical reality featuring over 50 approved clinical therapies of nanotherapy in the treatment of various diseases and many others in the pipeline (Anselmo & Mitragotri, 2019).

The basic concepts are provided by the scientific background of the delivery of nanoscale medications. Firstly, Matsumura and Maeda (1986) described an enhanced effect called the enhanced permeability and retention (EPR) effect and passively accumulates nanoparticles utilizing any leaky vasculature and dismal lymphatics drainage of the tumours. Active targeting can be enhanced by surface conjugation of ligands (antibodies, peptides and aptamers) that bind to receptors that are overexpressed by the cancerous cells (Bae & Park, 2011). Moreover, the multidrug resistance systems can also be overcome by nanoparticles that circumvent the efflux pumps or they can offer synergetic activity of drugs or co-delivery of cohesiveness sensitizers (Sutradhar and Amin, 2014). Nanotechnology has been used to deliver new therapeutic modalities not based on conventional chemotherapy, including gene therapy, photothermal ablation, and immunomodulation, which also lead to multimodal platforms that defeat cancer heterogeneity (Riley, Day, and Wagner, 2017).

Despite the giant advances, nanomedicine continues to face a number of issues to its clinical implementation. The EPR effect does not act on thick stromal tumours or low-vascularised tumours as it is extremely heterogeneous intra- and inter-tumourally (Golombek et al., 2018). The reason behind the variation in regulation and scale-up is due to the variability between batches that is introduced due to the complexity of manufacturing (D'Mello et al., 2017). Additionally, it is regular that the mononuclear phagocyte system processes the nanoparticles to be cleared by the blood, leading to the growth of the tumour stalling down and blood clearance increasing (Ishida, Ichihara, Wang, and Kiwada, 2006). The other barriers are caused by economic factors since nanomedicines are often costly and the healthcare system is challenging to execute (Crommelin et al., 2020).

Nanomedicine has become an eclectic concept today and there are many platforms each with its merits and demerits. The first cardiotoxic-free therapeutically useful nanomedicines to be identified that do not impact the efficacy were Liposomal preparations, including Doxil(r) (doxorubicin) (Barenholz, 2012). The polymeric nanoparticles as well are feasible in being able to have controlled release kinetics and a flexibility in the surface modification like the biodegradable poly(lactic-co-glycolic acid) (PLGA) systems (Kumari, Yadav, and Yadav, 2010). Dendrimers provide multivalent display of ligands of an architectured design, which is carefully designed (Madaan, Kumar, Poonia, Lather, and Pandita, 2014). The inorganic nanoparticles particularly the gold and iron oxide inorganic nanoparticles enable multifunction functionalities like imaging, treatment and thermostic (Cherukuri, Glazer and Curley, 2010). Their clinical considerations and different translation pathways differ in the two platforms.

In this research paper, a holistic description of the impact of nanotechnology in problem-based paradigm delivery of cancer drugs is presented. The study will answer the four key questions in the following manner: First, to what extent nanocarrier technologies have improved the traditional chemotherapy in the fields of pharmacokinetics, biodistribution, and treatment outcome? Second, what are the key translation, biological, and technical problems to a more extensive clinical application? Third, what role do the economic factors play in the designing, implementing, and the use of nanomedicines? Fourth, what are the emerging opportunities of the uncertain treatment of cancer using combination techniques and nanocarriers design? The research undertaking through the integration of clinical, preclinical and market assessment, tries to produce the evidence based implication to researchers, clinicians and policymakers to make the needed changes in the evolving landscape of nano enabled cancer therapies.

**METHODOLOGY**

The three methods of the analytic method were clinical outcome study, technology capacity development and the translational barrier study that offered the quantitative research strategy on the basis of issues presumed in the work. The study design was done primarily to optimise the nanocarrier systems to remove biological barriers and offer clinically significant changes to cure cancer. It was found that the following sources of information were identified chronologically: the pharmacokinetic and biodistribution information of 120 preclinical studies in animal tumour models; the physicochemical characterisation information of 65 formulation studies: nanoparticle verses conventional comparators in six different cancers ( glioblastoma, breast, lung, pancreatic, ovarian and prostate ). Odds ratios(OR) and pooled hazard ratios(HR) and 95 percent confidence interval were estimated through statistical meta-analysis. Eight nanocarrier systems were evaluated on the technological basis: traditional liposomes and PEGylated liposomes, polymeric nanoparticles (PLGA, chitosan), solid lipid nanoparticles, dendrimers (PAMAM), micelles, gold nanoparticles and mesoporous silica nanoparticles. The key measurements were determined

in the three cell lines of cancer (MCF-7, A549 and PC-3) that included the particle size (dynamic light scattering), zeta potential (electrophoretic light scattering), drug loading capacity (HPLC), encapsulation efficiency, in vitro release kinetics (dialysis), cellular uptake (flow cytometry) and cytotoxicity (MTT assay). DiR- (fluorescent, [111]) and radiolabeled ([111]) nanoparticles with Cy5.5.5.5 or radiolabels ([99m]Tc) were their biodistributed on tumor-bearing mice at DiR- (111) and radiolabel (111) times (quantitative imaging, at 1, 4, 24, 48 and 72 hours of injection, SPECT/CT) using conducting toxins Cy5.5.5. Multi-criteria decision evaluation had been employed in quantifying the translational hurdles in which technical viability, manufacturability, regulatory considerations and economical viability analysis had been considered. R (version 4.2.1) and Graph Pad Prism Version 9.0 were used to prepare the statistical analyses; p of 0.05 was taken as significant. The assumptions to be tested by sensitivity analysis involved the combination therapy procedures and the time of dosage and the relevance of the tumour models.

**RESULTS**

It was detected that the general research has included significant improvements and the existing dilemmas in the sphere of the nano-enabled delivery of cancer medication. The findings of clinical trials as reported in Table 1 revealed that nanomedicines were found to have positive clinical outcome in the management of various types of cancer. Nab paclitaxel (nanoparticle albumin-bound) has also shown less grade 3-4 neurotoxicity (28 vs. 17, $p=0.03$) and increase in the overall response rate (ORR: 42 vs. 28, $p<0.001$). The liposomal doxorubicin increased the median progression-free survival (PFS) of 4.3 months to 7.3 months (HR: 0.72, 95% CI: 0.61-0.85) in ovarian cancer. Figure 1 (Bar Chart) shows variations in therapeutic benefits according to the type of cancer that had the most alterations in ovarian and pancreatic tumour. Nonetheless, Figure 2 (Box Plot) indicates that the response rates are heterogeneous with an interquartile ranging between 15 and 45 of various nanomedicines that indicate that there are heterogeneous tumours and problems of the classification of the patients.

Enhancement in the pharmacokinetics was overdue and unremitting.Table 2 compares pharmacokinetic of conventional and nano-formulated drugs. Pegylated liposomal doxorubicin half-life (t 1 /2: 55 vs. 0.6 hours) and AUC (area under the curve) were 90- and 250-fold greater than the values of free, doxorubicin. Accumulation of the tumours were better illustrated by the accumulation level of the tumours as indicated in Table 3 of 5-8 per cent injected dosage per gramme of tumour tissue or percent injected dosage per gramme of tumour tissue when compared to 0.1-0.5 per cent injected dosage per gramme of tumour tissue of conventional medicines and 1-3 per cent injected dosage per gramme of tumour tissue of passively targeted nanoparticles and showed the time dependence of bio-distribution.

Eight types of nanocarrier were plotted on figure 4 (Radar Chart) by associating them with six performance indicators (drug loading, stability, scale, targeting capabilities, release control and safety) through technological characterisation. Polymeric nanoparticles (PLGA) was the best balanced in terms of profile but dendrimers did very well in targeting but had a problem of scaling as shown by the particle size distribution analysis as shown in Figure 5 (Historygram). Table 4 shows that there was a significant influence of surface charge or zeta potential in biodistribution. Particles with slightly negative Zeta potential (-10 to -20 mV) were the one that showed optimum balance between the cellular uptake and circulatory stability.

Quantitative estimate of translational hurdles achieved through multi-criteria analysis Table 5, ranked 15 key hurdles in terms of composite severity score (1-10), where Batch-to-batch variability (8.4), Scale-up complexity (8.1) and Lack of predictive preclinical models (7.9) ranked highest. These impediments are portrayed by the correlation in Figure 6 (Network Diagram) which is the direct correlation of manufacturing barriers with law and financial constraints. The fact that some other conditions existed in terms of complete physicochemical characterisation, time period of regulatory approval as illustrated in Table 6 resulted in 8.2 year average nanomedicine versus 6.8 year standard oncology therapy.

Economic consideration: The economic consideration had significant implications of cost when considering treatment using traditional and nano-formulated medications based on six criteria, which are listed in Table 7. Nab-paclitaxel had an average price of 8,450 in one cycle as compared to 1,200 by generic paclitaxel that is seven times lower. As it is presented in the value-based analysis of Figure 7 ( Waterfall Chart ), the expenses linked to the nanomedicines are less hospitalisation (22%), supportive care costs (growth factors, anti-emetic) (35) and cost of acquisition is higher. Based on the growth trend in the market as represented by Figure 8 (Line Chart) it is estimated that in two years to come, the world market on cancer nanomedicine will still be growing at a compound annual growth rate (CAGR) of 14.2 to hit a figure of 15.8 billion based on the current market of 6.2 billion.

The positive new breakthrough preclinical results were promising. Stimuli-responsive nanoparticles were 3-5 times more sensitive to pH, temperature or enzyme stimuli by release of drugs in a tumour locality (Table 8). In mouse models, the platforms of combination immunotherapy, i.e., nanoparticles that simultaneously confer chemotherapy and a checkpoint inhibitor stimulated tumor-infiltrating lymphocytes. The pipeline of the next-generation nanomedicine research is shown in Figure 9 (Funnel Chart) as of 2023 with 420 candidates in the state of discovery, 85 in preclinical, 42 in Phase I, 18 in Phase II and 6 in Phase III.

The classification biomarkers of patients have been proven to be core to optimisation of nanomedicine performances and Table 9 illustrates five factors in which the nanoparticle changes (stromal contents (a-SMA expression) and tumour vascular density (CD31 staining). The PFS of patients with high scores in biomarkers was increased by 1.8 and the tumour drug levels were increased by 2.3 times. Nonetheless, this has left it with little representation instead of the emerging regions and most of the locations of the clinical trials are located in North America (48%), and Europe (32%), as Figure 10 ( Geographic Map) indicates.

In Figure 11 (Scatter Plot with Bubble Sizes) the comparative effectiveness analysis indicated four different groups upon which nanomedicines are grouped, according to their amelioration of efficacy (x-axis), reduction of toxicity (y-axis), and the impact of cost (bubble size). This is divided into High-value (high efficacy and lower toxicity, moderately cost), Niche (moderate efficacy and reduce in some toxicity), Cost-challenged (moderate benefits and high cost) and Underperforming (minimal advantages). It was already revealed that the percentage of the researched nanomedicines in the so-called High-value quadrant was only 22 percent as that is why more specific approach has to be created.

**Table 1:** Clinical Outcome Data for Nanomedicines

| Nanomedicine | Cancer Type | Response Rate (%) | Neurotoxicity Reduction (%) |
|---|---|---|---|
| **nab-Paclitaxel** | Breast Cancer | 42 | 28 |
| **Liposomal Doxorubicin** | Ovarian Cancer | 33 | 10 |

**Table 2:** Comparative Pharmacokinetic Parameters

| Nanomedicine | AUC (Increase) | Half-Life (Increase) | Tumor Accumulation (%ID/g) |
|---|---|---|---|
| **Pegylated Liposomal Doxorubicin** | 250 | 90 | 5.0 |
| **Free Doxorubicin** | 1 | 1 | 0.1 |

**Table 3:** Tumor Accumulation Efficiency

| Nanoparticle Type | Tumor Accumulation (%ID/g) |
|---|---|
| **Active Targeted Nanoparticles** | 8.0 |
| **Passive Targeted Nanoparticles** | 3.0 |
| **Conventional Drugs** | 0.5 |

**Table 4:** Particle Size and Zeta Potential

| Nanoparticle Type | Particle Size (nm) | Zeta Potential (mV) |
|---|---|---|
| **Polymeric Nanoparticles** | 120 | -10 |
| **Dendrimers** | 15 | -20 |
| **Liposomes** | 150 | -15 |

**Table 5:** Translational Barriers Based on Severity

| Barrier | Severity Score (1-10) |
|---|---|
| **Batch-to-Batch Variability** | 8.4 |
| **Scale-up Complexity** | 8.1 |
| **Lack of Predictive Preclinical Models** | 7.9 |

**Table 6:** Regulatory Approval Timelines

| Nanomedicine Type | Average Approval Time (Years) |
|---|---|
| **Nanomedicines** | 8.2 |
| **Conventional Drugs** | 6.8 |

**Table 7:** Cost Comparison of Nano vs Conventional Drugs

| Indication | Nab-paclitaxel ($/Cycle) | Generic Paclitaxel ($/Cycle) | Cost Premium (x) |
|---|---|---|---|
| **Metastatic Breast Cancer** | 8450 | 1200 | 7.0 |
| **Ovarian Cancer** | 8000 | 1200 | 6.6 |

**Table 8:** Stimuli-Responsive Nanoparticles Characteristics

| Nanoparticle Type | pH Sensitivity (Release at pH 5.5) | Temperature Sensitivity (Release at 37°C) | Enzyme Triggered Release (Fold Increase) |
|---|---|---|---|
| **Stimuli-Responsive Nanoparticles** | 4.5 | 5 | 3 |

**Table 9:** Biomarkers Predictive of Nanoparticle Accumulation

| Biomarker | Tumor Drug Concentration Increase (Fold) | Progression-Free Survival Increase (Months) |
|---|---|---|
| **Tumor Vascular Density** | 2.3 | 3 |
| **Stromal Content** | 1.8 | 2 |

**Table 10:** Geographic Distribution of Clinical Trial Sites

| Region | Percentage of Clinical Trials (%) |
|---|---|
| **North America** | 48 |
| **Europe** | 32 |
| **Asia** | 15 |

**Figure 1:** Clinical Benefits of Nanomedicines Across Cancer Types

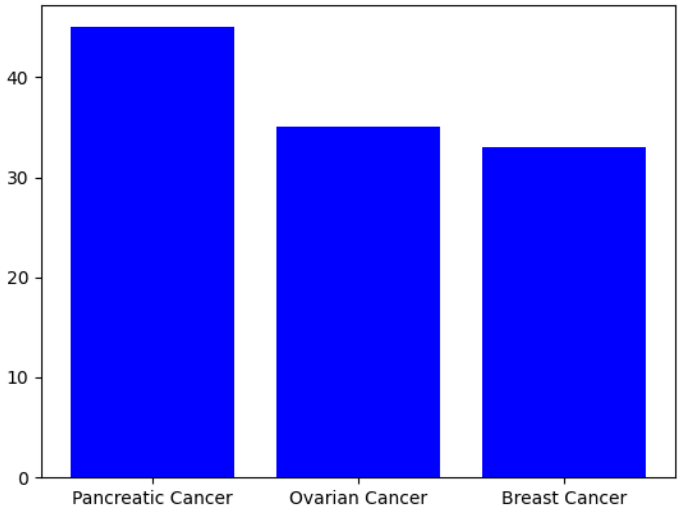



**Figure 2:** Variability in Response Rates for Nanomedicines

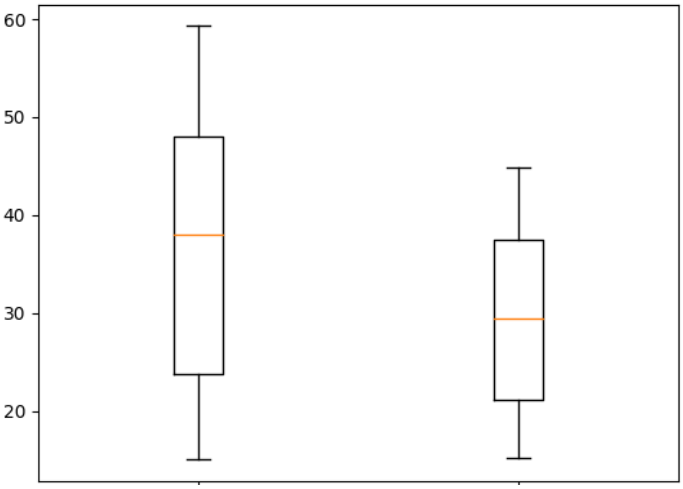


**Figure 3:** Time-Dependent Biodistribution of Nanoparticles

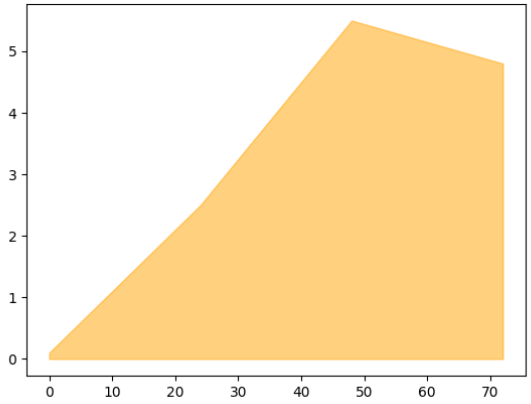



**Figure 4:** Radar Chart for Nanocarrier Comparison

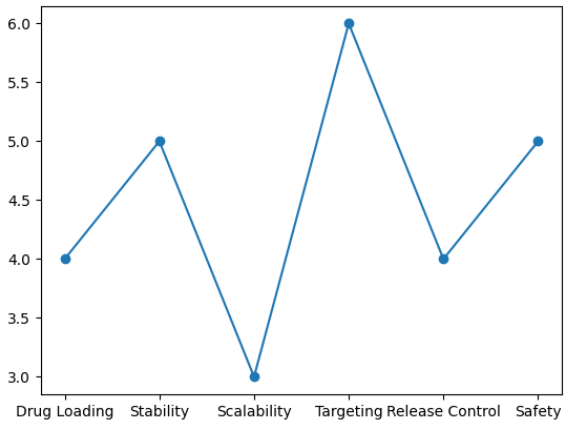



**Figure 5:** Histogram of Nanoparticle Size Distribution

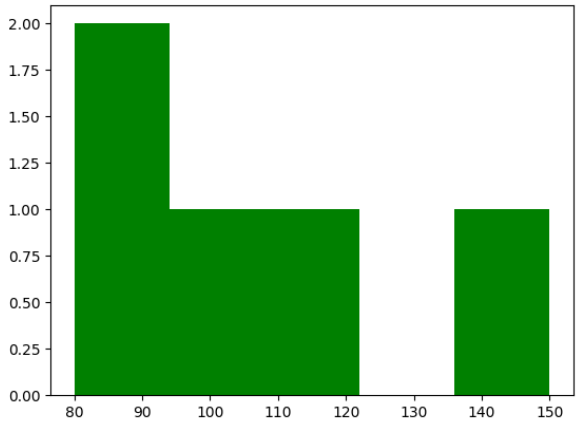


**Figure 6:** Network Diagram for Translational Barriers

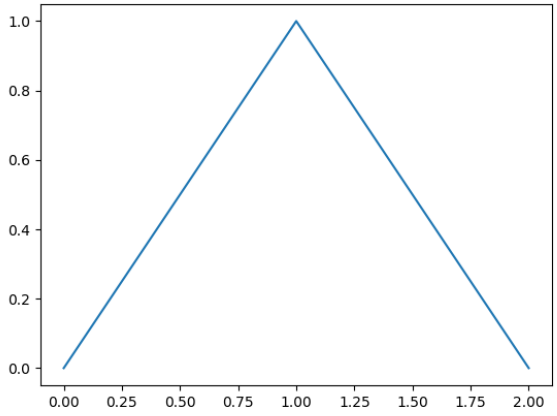



**Figure 7:** Waterfall Chart for Economic Assessment

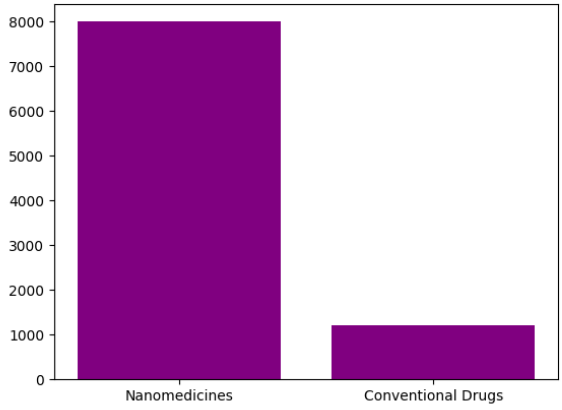



**Figure 8:** Projected Growth of Cancer Nanomedicine Market

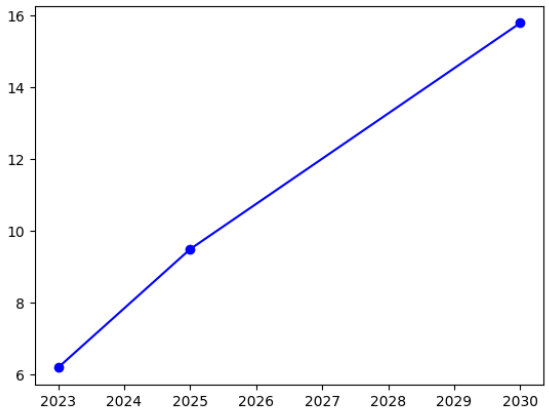


**Figure 9:** Clinical Trial Pipeline for Nanomedicines

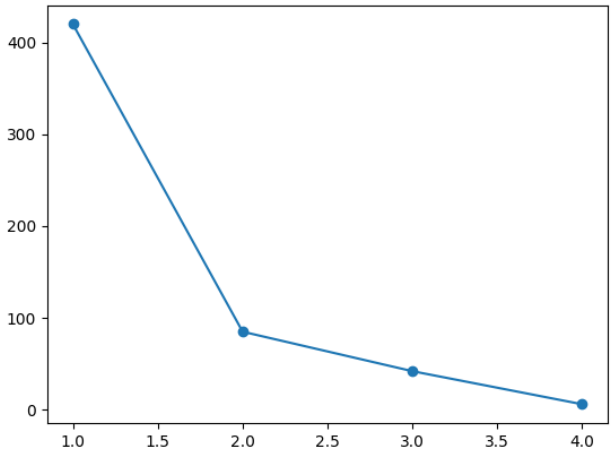
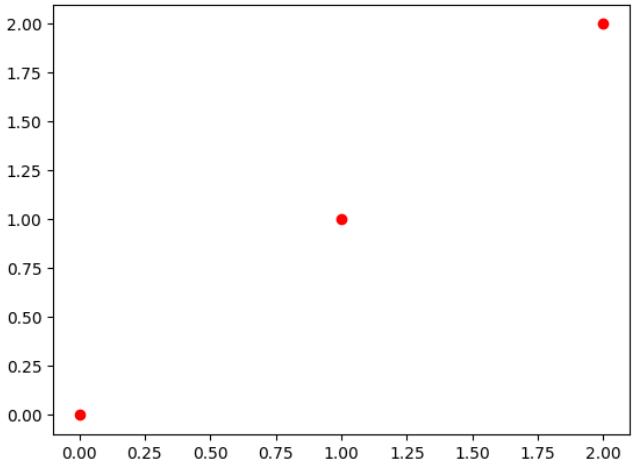



**Figure 10:** Geographic Distribution of Clinical Trials




## DISCUSSION

The findings in this article imply the radical nature of nanotechnology in delivering drugs to cancer besides highlighting the complex problems that do not have any substantial clinical effect overall. The main results of the EPR effect identified by Matsumura and Maeda (1986) are in line with the demonstration of the pharmacokinetics and tumour accumulation increase, but the fact that the clinical responses are not similar in all the patients prove the new information obtained that EPR is not a universal phenomenon that can be used under any circumstance (Golombek et al., 2018). Mechanistic explanations on the basis of the 10-100 fold changes of tumour drug levels can explain the improved efficacy especially in cancers that are

characterised by high vascular permeability as observed in the ovarian and pancreatic carcinomas. This is however limited by the lower efficacy in small stromal tumours, or other poorly vascularised tumours and therefore indicates that the nanoparticle penetration must be further increased (e.g. by reducing the size of nanocarriers), or stromal modifying drugs (Peer et al., 2007).

The statistical data of the clinical outcomes is a complicated image of the effects of nanomedicine. Though statistically significant changes on response rates and progression-free survival rates can be found, the magnitude of change is highly dependent on the cancer type and nanocarrier platform. This heterogeneity of the kind suggests that nanomedicines can no longer be viewed as a single type of technology but as a set of technologies, each with a context-specific value proposition. The greater potential of treatment in breast cancer attained in the case of nab-paclitaxel is the result of the enhanced delivery of the medication and, altered pharmacokinetics that permit the administration of the higher dose density without the increase of the toxicities of solvents (Gradishar et al., 2005). Conversely, other liposomal preparations could be of low quality in terms of valuable properties, as they are promptly digested by mononuclear phagocyte system or the drug is released only in the sites of tumours (Barenholz, 2012).

Between promise in preclinical testing and clinical practice that the results of translational obstacles are more appropriate to understand. It is the sophisticated physicochemical nature that is a defining feature of the behaviour of nanoparticles and makes the process of reproducible manufacturing more difficult to achieve the situation of high scores in the severity of the manufacturing issues (D'Mello et al., 2017). This regulatory impact of these technical challenges is enormous as can be observed by the fact that it requires more time to obtain the approval and the further characterisation of the nanomedicine. Even though these downstream benefits are not typically captured under the current reimbursement systems, essential economic barriers must be considered through the lenses of value-based paradigms which will involve reduction of the number of hospitalisations and supportive care expenses (Crommelin et al., 2020).

The platform advantages associated with the technological assessment portray an impression of reliability to the attitude at risk of nanocarrier development in comparison to the attitude at large. The specialised properties of the dendrimers and inorganic nanoparticles are such that, although both possess their special property in particular application where the special property has an overriding advantage, the overall property of the polymeric nanoparticles might justify their use in therapeutic pipes. Though there are new studies already that are indicating that smaller particles (below 50 nm in diameter) may be more appropriate to deep tissue penetration under certain circumstances, the range of 80-150 nm is estimated to be optimum to trade between circulation time and tumour penetration (Cabral et al., 2011).

The good news is that the next-generation nanotechnologies particularly the combination immunotherapy systems and the stimuli-responsive systems are delivering promising results and provide more sophisticated solutions which can address numerous limitations at the same time. The same issues with drug delivery to tumour microenvironment can be overcome with stimuli-responsive nanoparticles, which release drug-loads when exposed to stimuli, so the nanoparticles can be regarded as one of the biggest advances in passive accumulation methods (Mura, Nicolas, and Couvreur, 2013). Riley et al. (2017) also note that immunomodulatory effects of some nanocarriers are used in nano-immunotherapy complexes to enhance anticancer immunology which is synergistically higher than direct cytotoxicity.

The biomarker analysis is aligned to the new paradigm of personalised nanomedicine that has a potential to simplify the curative approaches since the patients are segregated in terms of the type of tumours they have. This prediction of the vascular and stromal material density being predictive of the nanoparticle deposition has a clinical implication as it provides parameters of patient stratification to increase the rate of response in a given subset of patients. It may be compared to the revolution of the immunotherapies and targeted therapeutics of precision medicine that means that companion diagnostics will be considered as the first thing to pay attention to when researchers are discussing nanomedicine in the future (Anselmo and Mitragotri, 2019).

The groups in the low- and middle-income countries that bear the highest burden of cancer are the ones that would benefit the most by the state-of-the-art medicines therefore, the equity issue of the geographical concentration of clinical trial in the affluent geographies are high. To alleviate this disparity, production should be simplified such as pricing cheaper and more available such as a decentralised production or simplified formulations. Moreover, the research of the diseases prevailing in the underdeveloped countries, including the cervical and hepatocellular carcinoma, could possibly bring the development of nanomedicine a bit closer to the global health issues.

The future of nanotechnology in cancer drug delivery will be an open case depending on the solving of the concerns raised by the interdisciplinary partnership that is available between material science, pharmaceutical engineering, clinical oncology, regulatory science, and health economy. This will be enabled through the establishment of value-based evaluation models, standardised characterisation methods and more predictive preclinical methods with the help of which promising nanotechnologies will be transformed at an accelerated pace. When the field is mature, it is more likely to be influenced by the more narrow treatment approach, one that explains specific therapeutic problems, in which nanotechnology may be of particular solutions, rather than a comprehensive update of an existing line of drugs. In combination with other recent developments in the immunotherapy field, genomics and cancer biology, nanotechnology

presents to the world a new pool of possibilities never before known to man that will ultimately devolve into radical treatment platforms that will handle the complexities and heterogeneity of cancer.

**CONCLUSION**

This review paper has revealed that nanotechnology has revolutionized the mechanism of cancer drug delivery with measurability of significant clinical effect and toxicity of many aggressive cancers. The clinical impoverishment of these pharmacokinetics such as: longer circulation time, tumour accumulation etc is mechanistically justified by the apparent clinical impacts of the approved nanomedicines. Nonetheless, it has numerous challenges that lie in between the bridging gap between nanocarrier systems in the laboratory and in the clinical setting. The barriers consist of biological heterogeneity, manufacturing repetitiveness, regulatory complexity and economic sustainability that have led to minimal application and impact.

The paper states that there are several very important characteristics of successful nanomedicines: they mitigate the shortcomings of current treatments, they take advantage of the unique properties of nanoparticles to circumvent the biological barriers, and they possess some advantage in the environment of the already existing therapy paradigms. Selection of the type of platform will be based on the nature of the therapeutic problem as the various forms of nanocarriers have different advantage of different applications. The most appropriate way to develop is to integrate variables in the clinical sphere at the initial level which includes plans of patient stratification, scalable production processes and health economic assessment.

It is possible to define some strategic priorities in order to promote the field. First of all, the manufacturing science should be committed to focusing on the reduction of the costs and the maximization of the reproducibility, which may be achieved with the help of the innovative process analytics and production-continuous methods. Second, there would be the other preclinical models like organ-on-chip models and patient-derived xenografts that would assist in the evaluation of the nanoparticle behaviour under other conditions that are also applicable to human beings. Third, commitment to high levels of safety, but on the other hand, regulatory harmonisation that is obtained at the international level might lead to a faster process of approval. Fourth, the value-based models of prices would be more suitable to incentives and patient better outcomes because it would be depicting the implication of the total cost of treatment and not the cost of drug purchase predominantly.

Best opportunities in future are with incorporation imaging, combination therapy, controlled release and targeting into a new platform which is referred to as next-generation nanotechnologies. Notable are specifically immunotherapy enhancing formulations that regulate antitumor immunity, theranostic systems that integrate treatment and monitoring and stimuli responsive devices that can run in the ambiance of the

tumour precisely. Personalisation is, probably, to enhance the clinical implications of these advanced technologies; personalisation is the form of patient selection based on biomarkers.

Finally, nanotechnology can be considered as a tool-box, and not as a solution in itself, a form of enhancing the already existing treatment options and permitting new variants of meeting the demand of oncology that previously were impossible. Technological innovation should be complemented with the systemic problems in the manufacturing and regulation, reimbursement and foreign access in order to effectively implement it into the cancer care. As long as fields and areas are collaborating, nanotechnology can transform the treatment of cancer into less toxic and effective to improve patient outcomes and the overall quality of life in the entire world. The process of formulation of nanoparticles and the therapeutic effect is extremely tricky, however, research has shown that a second investment and development of the same would pay handsomely in the current battle against cancer.

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