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REVIEW

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Nab-Paclitaxel-Loaded Poly (Lactic-Co-Glycolic Acid) Nanoparticles as Microtubule B-Tubulin Stabilizer in the Management of Pancreatic Cancer

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ABSTRACT Pancreatic cancer, specifically driven by the Kirsten rat sarcoma virus gene mutation (KRAS), remains a formidable clinical challenge with limited therapeutic options. The absence of FDA-approved drugs directly targeting KRAS necessitates exploration of novel and more effective treatment strategies. This comprehensive literature review seeks to identify promising therapeutic avenues for pancreatic cancer by evaluating advancements in drug delivery systems. Nab-paclitaxel, an antimitotic agent, exhibits superior pharmacokinetic and bioavailability profiles compared to conventional paclitaxel. Utilizing poly (lactic-co-glycolic acid) (PLGA) nanoparticles as carriers, we investigate the potential of nab-paclitaxel-loaded PLGA nanoparticles to enhance drug delivery and efficacy. Manufactured through the oil-in-water emulsification solvent evaporation method, nab-paclitaxel-loaded PLGA nanoparticles offer a faster half-life and undergo elimination via biliary excretion and metabolism. Notably, these nanoparticles leverage nanoalbumin interactions with cysteine/osteonectin-rich, acidic secreted proteins, resulting in highly selective targeting of pancreatic cancer cells. The findings of this review underscore the potential superiority of nab-paclitaxel-loaded PLGA nanoparticles in terms of pharmacokinetics, pharmacodynamics, and clinical outcomes. Their ability to address the challenges posed by KRAS-driven pancreatic cancer holds promise as a transformative approach in the treatment landscape. In conclusion, this review highlights the evolving landscape of therapeutic options for pancreatic cancer, shedding light on nab-paclitaxel-loaded PLGA nanoparticles as a potent and selective intervention. Further clinical validation and exploration of this innovative strategy are warranted to advance the management of this devastating disease.

Keywords: Nab-paclitaxel; nanoparticles; pancreatic cancer; polylactic acid-polyglycolic acid copolymer

Pancreatic cancer has a poor prognosis, with a survival rate of approximately 9%.[1] It is the 14th most common cancer and the 7th leading cause of cancer deaths, with a total of 458,918 cases and 432,242 deaths globally in 2018.[2] The study by Saad et al. emphasized an increase in the pancreatic cancer prevalence by 1.03% annually from 1973 to 2014 and pancreatic cancer was predicted to be the second leading cause of death by 2030.[3] The pancreatic cancer prevalence increased by 39.53% at 55-64 years of age and more than 95% of cases had metastasized at the time of diagnosis or in the future.[4,5] This is a manifestation of mutations in the dominant isoform that is mutated in pancreatic cancer, that is, the Kirsten rat sarcoma virus (KRAS) gene sequence.[6] KRAS functions as a molecular switch that initiates intracellular signaling pathways and transcription factors inducing cell proliferation, migration, transformation, and survival, and mutations lead to uncontrolled cell growth leading to cancer.[7]

The first-line treatment of advanced pancreatic cancer has been single-agent gemcitabine for more than a decade.[8] Deoxycytidine kinase activates nucleoside diphosphate and triphosphate, leading to deoxyribonucleic acid (DNA) polymerase competitive inhibition, thus, impeding DNA synthesis through intracellular conversion by gemcitabine.[9] Chemotherapeutic agents have low efficacy and chemoresistance and prolong patient survival by less than one year.[10-13] Moreover, gemcitabine has certain side effects, in-

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cluding heart toxicity, peripheral edema, nausea, vomiting, and anorexia.[12,14,15] No current Food and Drug Administration (FDA) approved drugs directly target the KRAS mutation proteins.[16] This is owing to the challenges in the development of small molecule inhibitors that have a sufficiently high affinity for KRAS mutations. Moreover, KRAS mutations have an extremely high affinity for guanosine triphosphate (GTP), and their catalytic sites are small and difficult to target.[17] Additionally, the KRAS gene mutation impact can be inhibited by preventing the replication of mutated cells using antimitotic drugs, such as paclitaxel.[18]

The most significant advancement in chemotherapy for breast, endometrial, non-small cell lung, bladder, and cervical cancers in the last two decades is paclitaxel, the first identified microtubule stabilizing agent.[19] However, paclitaxel has a limited clinical application owing to its hydrophobicity and low therapeutic index.[20] Nonetheless, this limitation can be avoided through the use of new drug delivery systems such as poly (lactic-co-glycolic) acid (PLGA) paclitaxel nanoparticles with sizes up to 200 nm.[20,21] PLGA is an effective biodegradable polymer nanoparticle drug delivery system owing to its controlled and sustained release, low levels of toxicity, and tissue biocompatibility.[22] PLGA nanoparticles are formulated from biocompatible and biodegradable polymers and are used in research owing to their small size distribution, synthesis with controlled reaction time and temperature, high structural integrity, and high production rate.[23] The systemic delivery of insoluble compounds to tumor sites is facilitated by the encapsulation of various hydrophobic chemotherapeutics by PLGA nanoparticles.[21,24] An increased intratumoral concentration mediated by 60 kDa albumin-binding glycoprotein (gp60) is associated with increased tumor response to nab-paclitaxel, facilitating vascular transcytosis.[25]

Thus, this review aimed to determine better prospects regarding the management of pancreatic cancer by acknowledging the potential of paclitaxel and the use of PLGA nanoparticle technology.

PANCREATIC CANCER

The pancreas is a metabolic organ with both exocrine and endocrine roles.[26] The exocrine glands comprise pancreatic acinar and duct cells that induce digestive enzymes and sodium bicarbonate production, respectively.[27] Endocrine glands consist of 5 different types of secretory islet cells that produce peptide hormones to control glucose levels.[28] Pancreatic cancer arises from genetic defects and causes abnormal cell proliferation and function.[29] In pancreatic cancer, there is a loss and gain of chromosomes.[30] The chromosome arm 9p21, 17p13, 18q21, 3p, 8p22, and 6q are the most prevalent areas of genome loss in primary pancreatic cancer.[31-36] Genes related to tumor-suppressing, such as cyclin-dependent kinase inhibitor 2A (CDKN2A)/P16/MTS1 (in 9p21), p53 (in 17p13), and mothers against decapentaplegic homolog 4/SMAD family member 4 (SMAD4)/deleted in pancreatic cancer 4 (in 18q) are found in these loci.[37-40] Fluorescent in-situ hybridization demonstrated increased DNA regions at 12p, 12q, 17q, 19q, and 20q.[41] The amplified sites are consistent with the locations of the oncogenes AKT serine/threonine kinase 2 (AKT2) (in 19q), KRAS (in 12p), mouse double minute 2 homolog (in 12q), Erb-b2 avian erythroblastic leukemia viral oncogene homolog 2 (in 17q) and amplified in breast cancer 1 (in 20q).[42-48] KRAS, the most frequently mutated oncogene (90%) in pancreatic cancer, is located on the 12p arm of the chromosome.[49] A meta-analysis of 34 studies on P53, SMAD4, CDKN2A/P16, and KRAS, containing 3373 samples, found that KRAS (hazard ratio=1.68, 95% confidence interval=1.27-2.22, $p<0.001$) had the highest mutational significance in pancreatic cancer compared to other oncogenes.[50]

KRAS

A key component of cellular networks is the RAS protein that governs growth, proliferation, survival, differentiation, adhesion, cytoskeletal rearrangement, and cell motility through a variety of signaling pathways (Figure 1).[51] Three members of the RAS gene family, which includes Harvey rat sarcoma virus, KRAS, and neuroblastoma rat sarcoma virus, act as proto-oncogenic factors in human tumor activation.[52] The KRAS mutation is an early genetic event for pancreatic cancer.[53]

KRAS can only bind and activate effector proteins like rapidly accelerated fibrosarcoma (Raf)-ki-

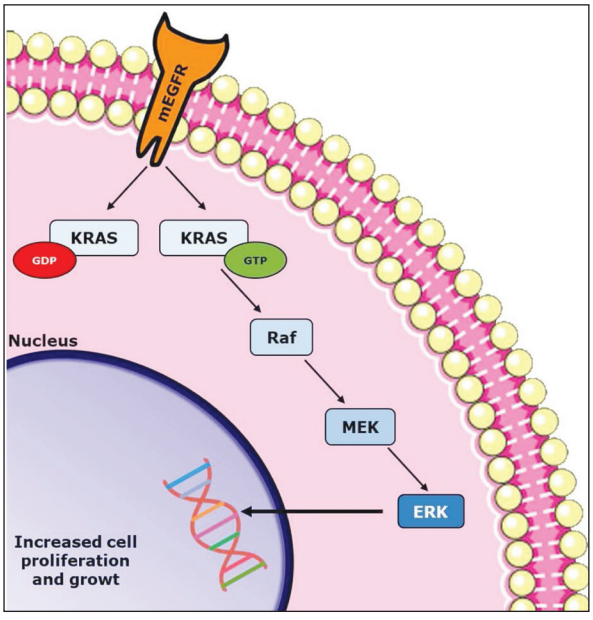

FIGURE 1: Ras/Raf/MAPK (MEK)/ERK pathway.
Ras: Rat sarcoma virus; Raf: Rapidly accelerated fibrosarcoma; MAPK: Mitogen-activated protein kinase; ERK: Extracellular signal-regulated kinase; mEGFR: Mutant epidermal growth factor receptor; KRAS: Kirsten rat sarcoma virus; GDP: Guanosine diphosphate; GTP: Guanin triphosphate.

nase, phosphoinositide 3-kinase, and Ral guanine nucleotide dissociation stimulator when it is GTP-bound.[54] KRAS is activated when the protein guanosine exchange factor supersedes guanosine diphosphate from the nucleotide-binding site owing to higher intracellular GTP concentrations.[55] KRAS signaling hyperactivity, which can occur through direct KRAS mutation or indirectly through other proteins in the KRAS pathway, leads to Raf activation in the Ras/Raf/MAPK (MEK)/ERK pathway.[56,57] This pathway plays an important role in tumor cell survival and development.[58] This subsequently causes uncontrolled cell proliferation. Several attempts have led to the identification of compounds that specifically block important factors for mitosis in cancer therapy.

NAB-PACLITAXEL AND POLY (LACTIC-CO-GLYCOLIC) ACID

Antimitotic chemotherapeutic agents, such as vinblastine and taxol, halt the cell mitotic cycle progression, causing cancer cells to undergo apoptosis.[59] The microtubules create spindles during prophase to draw the chromosomes toward the poles. During the later stages, the microtubules undergo depolymerization, dissolving the structure.[60] Paclitaxel binds and stabilizes microtubules, preventing depolymerization (Figure 2).[61] Therefore, tubulin polymerization is promoted, and mitotic progression is inhibited by paclitaxel.[62] Despite using paclitaxel in the management of various cancers, including cervical, breast, ovarian, bladder, prostate, liver, and lung, the clinical application of paclitaxel is highly limited owing to its efficacy and multi-drug resistance (MDR) properties.[63] Nanoparticles have become the treatment of choice for cancer owing to their good pharmacokinetics, precise targeting efficacy, reduction of side effects, and more significant anti-drug resistance without increasing therapeutic hazard to patients.[64,65]

Nab-paclitaxel is a type of taxane that interferes with cell division and prevents the growth and spread of cancer cells.[66] Unlike conventional paclitaxel, formulated using a solvent called Cremophor EL (Sigma Chemical Co., St. Louis, Missouri, United States) that can cause severe allergic reactions and other side effects in some patients, nab-paclitaxel is formulated with albumin-bound nanoparticles delivering the

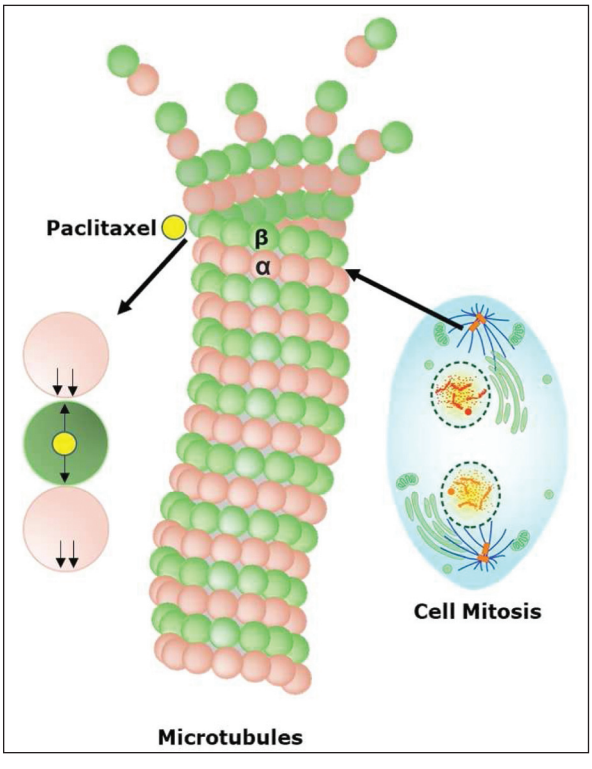

FIGURE 2: Paclitaxel as β-tubulin stabilizer in cell microtubules.

drug more efficiently to the tumor cells.[66] These nanoparticles protect the drug from degradation and clearance (CL) by the body's immune system, allowing for more drugs to reach the tumor cells.[67,68] Furthermore, the nanoparticles can bind to a specific protein found on the surface of tumor cells, enhancing the drug's ability to enter the cells and exert its therapeutic effects.[68] Nab-paclitaxel has a higher response rate and improved progression-free survival (PFS) compared to conventional paclitaxel. For example, in a Phase III clinical trial comparing nab-paclitaxel to conventional paclitaxel in patients with metastatic breast cancer, nab-paclitaxel was associated with a higher overall response rate (ORR) (33% vs. 19%) and longer PFS (23.0 vs. 16.9 weeks).[69] The use of albumin-bound nanoparticles in nab-paclitaxel mitigates the potential occurrence of allergic reactions and other adverse effects. Notably, nab-paclitaxel is associated with lower incidence rates of all-grade neuropathies, anemia, pain, and diarrhea than paclitaxel, while also significantly reducing the use of antiemetics and antihistamines.[70,71] The unique formulation of nab-paclitaxel with albumin-bound nanoparticles improves the drug's efficacy while reducing its side effects, thus, making it a superior chemotherapeutic drug compared to conventional paclitaxel.

However, the clinical utilization of paclitaxel is restricted by its low solubility, prompting the exploration of alternative delivery methods. Thus, PLGA nanoparticles, which are modified using tocopheryl polyethylene glycol succinate (TPGS) and vitamin E via solvent evaporation, have been utilized to encapsulate paclitaxel and control its release in vitro, to address this limitation.[72] PLGA, an FDA-approved synthetic polymer, shows great promise as a drug delivery vehicle owing to its biodegradability, biocompatibility, and ease of surface modification for site-specific drug release.[73] Nanoparticle encapsulation of anticancer drugs enhances release rates while reducing the risk of toxicity owing to the large surface area-to-volume ratio and targeted delivery.[74] According to a study, the atomic force microscopy findings indicated no alterations in the physical properties of PLGA nanoparticles after loading paclitaxel in pancreatic cancer cells, which was supported by a similar modulus in paclitaxel-loaded PLGA nanoparticles of approximately 12 GPa; thus, verifying the feasibility of loading paclitaxel into PLGA.[21] Previous clinical trial indicates that the use of polyethyleneimine-formulated PLGA nanoparticles results in increased cellular uptake, sustained siRNA, and effective gene deliveries.[75] In contrast to conventional liposomes with a half-life of less than 10 h, PEGylated PLGA liposomes demonstrate a longer elimination half-life of approximately 50 h, resulting in higher intratumoral paclitaxel accumulation and improved antitumor efficacy in mice with colon-26 solid tumor-bearing.[76,77] The existing literature suggests that PLGA in combination with nab-paclitaxel could potentially yield considerable therapeutic benefits, despite the limitations of current clinical trials investigating the efficacy of this integration.

MECHANISM OF CONSTRUCTION AND ADMINISTRATION OF NAB-PACLITAXEL-LOADED PLGA

To synthesize PLGA nanoparticles comprising biomacromolecules, the oil-in-water (o/w) emulsification solvent evaporation method has become the method of choice owing to its more preferable requirements. Firstly, PLGA is dissolved in an organic, volatile, hydrophobic solvent such as dichloromethane (DCM). Next, the mixture is emulsified in a large amount of liquid in the aqueous phase using an ultrasound or a high-velocity homogenizer and an emulsifier or surfactant, most commonly polyvinyl alcohol (PVA) or TPGS. Afterward, organic solvent from the mixture is eliminated to create particles either by using low-pressure evaporation or dilution with large volumes of water or some other cooling agents to spread the solvent out. Lastly, the excess PVA or TPGS is removed and freeze-dried by rinsing the solid particles.[78]

The nab-paclitaxel-loaded nanoparticles are prepared using the o/w emulsification solvent evaporation technique (Figure 3). Firstly, 5 mg of paclitaxel is dissolved in a flask containing 4 mL of DCM with a 2.5% (w/v) PLGA. The resultant product was put into 20 mL of 1% (w/v) TPGS while stirring and sonicating. A prepared magnetic stir plate should swirl the remaining emulsion continuously at 25°C for approximately 6 h to evaporate the DCM. Following this, produced nanoparticles will be centrifuged and

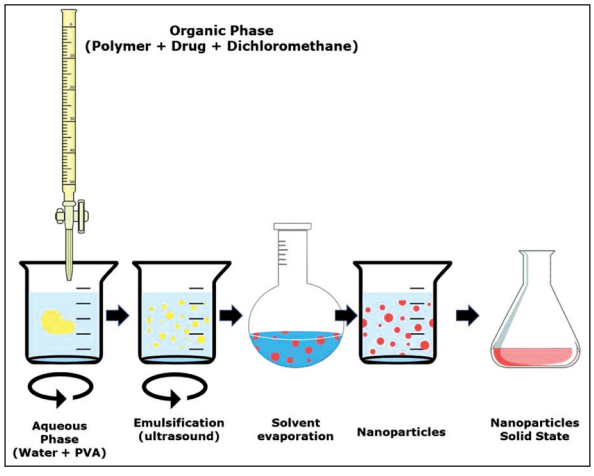

FIGURE 3: Schematic representation of the oil-in-water emulsification of solvent evaporation preparation method.
PVA: Polyvinyl alcohol.

rinsed with distilled water multiple times. The nanoparticles are then lyophilized and stored at 4°C before the next use.[79,80] Additionally, the morphology of the nanoparticles is determined using scanning electron microscopy, and the size of the nanoparticles on the electron micrograph is assessed using Adobe Photoshop (Adobe Systems, San Jose, California, United States).[81] Afterwards, 5 mg of paclitaxel-loaded nanoparticles are dissolved in 1 mL of DCM. Then, 3 mL of a 50:50 v/v acetonitrile: water mixture is added and extracted. A continuous nitrogen stream is used to evaporate DCM, which will then result in a clear translucent solution. High-performance liquid chromatography (HPLC) equipment is used to identify the composition of the resulting mixture. The HPLC test is performed at a flow rate of 1.0 mL/min with a 50:50 (v/v) combination of acetonitrile and water. A variable wavelength detector is used to detect paclitaxel. The calibration curve for paclitaxel quantification can then be linear across the standard range between 50 to 100,000 ng/mL with a correlation value of R^2=1.0.[82-85]

The recovery efficiency factor of the extraction procedure of encapsulation efficiency (EE) was determined to assess a certain weight of pure paclitaxel. Approximately 5 mL of phosphate-buffered saline (PBS) was added. The extraction technique as described previously was used and the drug's efficiency was then determined as a result.[86] The following formulae are used to know the loading efficiency and EE:

Loading efficiency (%)=(amount of drug in nanoparticles/number of nanoparticles loaded with drug)×100 EE (%)=(amount of drug in nanoparticles/initial amount of drug)×100. A deep HPLC test in PBS with a pH of 7.4 was used to determine the amount of nab-paclitaxel released from nanoparticles. Approximately 5 mg of paclitaxel-charged nanoparticles are suspended in 10 mL of PBS in a sealed tube and shaken at 37°C and 120 rpm in an orbital shaker. The supernatant is then suspended in 1 mL of DCM to obtain the nab-paclitaxel concentration.[86-89] After weighing the syringe to reach the desired dosage of paclitaxel 10 mg/kg, the preparation is delivered with a dose volume of 1-1.5 mL, via stomach intubation.[90-92]

PHARMACOKINETICS OF NAB-PACLITAXEL-LOADED PLGA NANOPARTICLE

According to Stage et al., the most commonly used dosage regimen for paclitaxel is 175 mg/m^2 with a 3-h infusion. This popular dosage regimen is correlated with a median CL of 12 L/h/m^2 and a maximum concentration (C_{max}) of 5 mmol/L.[93] Additionally, the half-life of paclitaxel is estimated to be 6-13 h after intravenous administration.[94]

Paclitaxel is commonly administered intravenously; therefore, it enters the blood circulation and bypasses gastrointestinal absorption.[95] Following this, paclitaxel is distributed extensively throughout the body, and its concentration decreases through 2 phases.[95] The distribution throughout the peripheral body parts is indicated by the rapid decline of paclitaxel concentration, whereas the slow decline in the second phase indicates paclitaxel elimination.[3] Paclitaxel is metabolized in the liver to 6α-hydroxy paclitaxel by cytochrome 2C8, and to two minor metabolites, 3-p-hydroxy paclitaxel as well as 6α, 3′-p-dihydroxy paclitaxel, by cytochrome 3A4.[94,95] Paclitaxel is mostly eliminated through biliary excretion and metabolism, whereas renal CL plays a minor role.[94] Nab-paclitaxel was developed to improve the pharmacokinetics, pharmacodynamics, and safety profile by eliminating the potential toxicity of polyethoxylated castor oil components while the efficacy of paclitaxel was maintained or increased.[80,95,96] According to Giordano et al., nab-paclitaxel particles have a smaller diameter; therefore, there is an in-

crease in the intracellular distribution of paclitaxel and higher antitumor activity.[96] Apart from the larger volume of distribution, nab-paclitaxel also has a higher concentration and faster CL rate than conventional paclitaxel.[96]

One of the most effective and potent antitumor agents, nab-paclitaxel poses major challenges, namely extremely poor water solubility (<0.025 mg/mL), possible MDR in some tumor cells, and nonspecific pharmacokinetics in the systemic circulation.[79] Thus, to overcome these challenges, a nab-paclitaxel delivery system was developed, one of which is PLGA nanoparticles.[79] PLGA nanoparticles after surface modification, for example, through PEGylation, have the potential to increase blood circulation time and improve drug pharmacokinetics.[22] This was supported by an in vitro study by Wei et al., who found that curcumin-loaded PLGA synthesized by PEGylation had improved pharmacokinetic properties and increased drug bioavailability by up to 55.4 times.[7] Rezvantalab et al. concluded that PLGA nanoparticle implementation with the antitumor docetaxel-loaded PLGA accumulated lesser in the liver, spleen, and lungs compared to free docetaxel.[22,97] Therefore, PLGA nanoparticles demonstrate high potential in improving the pharmacokinetics of nab-paclitaxel as a treatment modality for pancreatic cancer.

PHARMACODYNAMICS OF NAB-PACLITAXEL-LOADED PLGA

Compared with paclitaxel molecules, nab-paclitaxel has a smaller molecular diameter structure, allowing intracellular transport of paclitaxel and better antitumor activity. Albumin binding facilitates the transport of paclitaxel across endothelial cells via the albumin receptor pathway, the gp60 receptor. This increases the number of paclitaxel that perform endothelial transcytosis by 4.2 times in the presence of albumin nanoparticles. The albumin nano bind also interacts with a glycoprotein receptor, secreted protein acidic and cysteine rich/osteonectin that is overexpressed in certain tumor cases, such as pancreatic ductal adenocarcinoma (PDAC), resulting in a much more selective action of nab-paclitaxel on tumor cells.[96] PLGA is advantageous in the drug delivery aspect of nab-paclitaxel, binding to the gastrointestinal mucosa to extend the duration of drug absorption. The hydrolysis of PLGA results in the formation of lactic acid and glycolic acid, which are endogenous materials that can be utilized in the Krebs cycle.[22] Owing to the biocompatible nature of PLGA, it can be modified into various shapes and sizes of desired particles to be compatible with various organic solvents to deliver nab-paclitaxel to specific tumor cells, in this case, PDAC cells.[22,98]

CLINICAL EFFECTS OF NAB-PACLITAXEL-LOADED PLGA

Nab-paclitaxel-loaded PLGA nanoparticles in the body are determined through the pharmacodynamic mechanisms, as a therapeutic method of therapy to manage pancreatic cancer, to inhibit the mitosis of cancerous cells, which is a therapeutic effect.[80,99] Paclitaxel exhibited a greater PFS with a result of 12.9 vs. 7.5 months (p=0.0065) and a superior ORR in a randomized multicentre study comparing the two first-line treatments in metastatic breast cancer, paclitaxel and docetaxel.[90,91] In contrast, an early Phase I clinical trial found that nab-paclitaxel has the maximum tolerated dosage of 300 mg/m^2, which is 70% greater than traditional paclitaxel (175 mg/m^2) and hence does not produce harmful side effects.[100]

Hersh et al. found that in Phase III clinical trial, the ratio of overall survival (OS) and ORR between dacarbazine and nab-paclitaxel was higher for nab-paclitaxel by 15% and 11%, respectively.[101] A Phase II study of 43 patients treated with 260 mg/m^2 every 3 weeks demonstrated a benefit in 49% of cases and a 16% ORR, with PFS and OS of 6 and 11 months, respectively.[102] Patients in the nab-paclitaxel group had a lower rate of hypersensitivity than those in the conventional group, according to Zong et al.[80,103] Gradishar et al. found that when nab-paclitaxel was compared to polyethylated castor oil-based paclitaxel, it had considerably greater response rates (33% vs. 19%; p=0.001).[104] According to studies done by Xu et al., delivering PLGA nanoparticles with a low molecular weight increases the rate of breakdown and drug release.[105] Furthermore, PLGA nanoparticles loaded with nab-paclitaxel demonstrated a 3.7-fold longer drug elimination half-life than the over-the-counter medications.[22,97]

In a Phase II trial, the desmoplastic stroma was discovered to be depleted in mice with human pancreatic cancer xenografts treated with nab-paclitaxel alone or in combination with gemcitabine.[106] In continuation to the previous study, it was discovered that the nab-paclitaxel-gemcitabine group exhibited 35% and 9% pancreatic cancer survival rates at 1 and 2 years, respectively, while the gemcitabine group had a pancreatic cancer survival rate of 22% and 4%, respectively. The nab-paclitaxel-gemcitabine group also showed a longer median PFS of 5.5 months compared to 3.7 months in the gemcitabine group.[106] An advanced nanoparticle system has been designed by Massey et al. to target pancreatic cancer by developing a multi-layered formulation of paclitaxel-loaded PLGA nanoparticles coated with poly-L-lysine and stabilized with Pluronic F127 (Bio-Engineering Co. Ltd, Xi'an, China). This formulation demonstrated desirable characteristics such as optimal size (~160 nm) and negative zeta potential (-6.02 mV), effective internalization mediated by lipid rafts, significant inhibition of growth and metastasis in vitro, and both chemo-naïve and chemo-exposed orthotopic xenograft mouse models of pancreatic cancer.[21] Similarly, Shetty et al. have reported the development of a distinctive paclitaxel-loaded PLGA nanoparticle formulation that is capable of targeting lipid metabolism and augmenting the anticancer activity of chemotherapy drugs in pancreatic cancer cells. Their study found that the paclitaxel-loaded PLGA could effectively inhibit excessive lipid formation and modify membrane stability by reducing the expression of fatty acid synthase, acetyl-CoA carboxylase, lipid, and Cox-2 proteins, as confirmed through. Fourier transform infrared and zeta potential measurements.[107] This suggests that the molecular mechanism enhances the efficacy, as demonstrated by its superior inhibitory effects in tumorigenic and metastasis assays in pancreatic cancer cells.

CONCLUSION

Nab-paclitaxel-loaded PLGA nanoparticles are a possible alternative in the treatment of cancer, which currently still has some drawbacks. Nab-paclitaxel-loaded PLGA nanoparticles have a higher endothelial transcytosis ability; therefore, the concentration of paclitaxel particles to target cells is higher and works more selectively. Nab-paclitaxel-loaded PLGA nanoparticles are constructed using the o/w emulsification solvent evaporation technique and administered intravenously. Nab-paclitaxel-loaded PLGA is extensively distributed and metabolized in cytochrome 2C8, where it is eliminated via biliary excretion. The drug target becomes more selective and undergoes higher endothelial transcytosis in the presence of albumin and PLGA binding. Based on a comparison with other treatment methods using various studies, the nab-paclitaxel-loaded PLGA nanoparticles showed pharmacokinetic and pharmacodynamic advantages.

RECOMMENDATION

Future studies are needed to develop this method, including drug dosage, therapy duration, the presence or absence of mutation effects, possible polypharmacy effects, and the costs involved.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

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