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Novel Polymer Platform for Smart Delivery of Drugs: Recent Developments and Future Prospects

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Abstract:

Drug pharmacokinetic parameters and biopharmaceutical properties play a significant role in drug safety and efficacy because they regulate the standard and quality of the medicine's ability to achieve intended goal. Long-acting medicine delivery technologies with multiple dosing frequencies encounter very serious problems including sub therapeutic plasma drug concentration, lower bioavailability, side effects and systemic toxicity leading to the poor conformity of patient. Using polymer platform to distribute drugs can resolve these issues. Platform technology can accommodate pharmaceuticals with similar physicochemical/therapeutic qualities while requiring little modification. Nanoparticulate drug delivery system, micro encapsulations, mucoadhesive techniques, self-micro emulsifying drug delivery systems (SMEDDS), nasal DDS, transdermal DDS, floating DDS are some of the potential representative polymer platform technologies that can address the issues related to conventional drug delivery technologies. Various synthetic, semisynthetic and natural polymers are utilised in the polymer platform technology including Chitosan, Ethyl cellulose, Poly (glycolic acid), poly lactic acid, "Hydroxy propyl methyl cellulose", "Carboxy methyl cellulose" and "Poly vinyl pyrrolidone" etc. This review article describes the need, advantages, various challenges and future perspectives associated with polymer platform DDS.

Keywords: Novel polymers, platform technology, drug delivery, pharmacokinetics, chitosan, ethyl cellulose.

INTRODUCTION

In the pharmaceutical industry, the process of developing novel therapeutic molecules is focused on assessing their efficacy, toxicity, and safety. The primary objective behind modification of drugs is the development of a "scientific database" supporting the efficacy and safety practices of the authority associated with dosage. However, the majority of "therapeutic molecules" fail in the medicine development process as their effectiveness; safety and impact have not been solely determined by their "pharmacodynamic properties". Drug pharmacokinetic ("clearance rate, half-life, protein binding, volume of distribution") and biopharmaceutical (e.g., "solubility, stability, permeability, and first-pass effect") and these aspects have a major impact on assuring the safety and quality of drugs **[1]**. Raw materials required from "drug development" can be modified to improve "oral bioavailability", and "patient acceptability", or upgraded launching of innovative medication by utilising a range of cutting-edge platform technologies. Customization of particle or crystal engineering services can be done to tune development needs **[2]**. Platform technology can accommodate pharmaceuticals with similar physicochemical/therapeutic qualities while requiring little modification. It consists of a polymeric system with a release modulator. A Company allows using one drug delivery technique for several drugs based on a platform drug delivery system. This builds an internal base of experience, which improves quality control, and better utilization of manufacturing facilities, it can also shorten the drug development process and scale-up times. The effectiveness of the system is directly related to its complexity **[3]**. Delivering tablets through the platform system avoids undesirable responses of drugs frequently related to toxicities and sub-therapeutic levels frequently related to suboptimal therapeutic effects. Another key aspect of the platform technology is the unique formulations that maintain the stability of large molecular weight drugs at human body temperature for extended periods. To ensure compliance and improve patient convenience advances in drug formulation allow continuous delivery of effective therapy with less frequent administration **[3]**.

BIOPHARMACEUTICAL PROPERTIES OF THE DRUG IN SUCCESSFUL THERAPEUTICS

Pharmaceutical research aims to obtain successful therapeutics. Major research approaches concentrate on pharmaceutics, pharmacology, and medicinal chemistry to have new and efficient active entities or optimized available entities **[3]**. Pharmaceutics concentrates on the administration of the raw drug in suitable dosage form while pharmacology relates with the "therapeutic effect" of the medicine at required areas. In research, the role of biopharmaceutics is equally important since it covers those aspects that help in maintaining optimum plasma drug concentration necessary to show therapeutic effects and avoid unwanted effects **[3]**.Optimum therapeutic impact and fewer adverse effects depend on the amount of drug present which in turn depends upon the amount of drug in the systemic circulation. A drug comes into circulation after its release from dosage form (pharmaceutics) and its fate in the form of distribution, metabolism, and elimination. The drug which enters the target organ shows a therapeutic effect that is again

related to the amount of drug in plasma. Thus biopharmaceutical parameters are the bridge between pharmaceutics and pharmacology and without them; the therapeutic goal cannot be reached **[4]**.

THE NEED FOR NOVEL PLATFORM DRUG DELIVERY SYSTEM

Long-acting drug therapy of traditional multiple dosing regimens faced many problems including plasma drug level showing irregular profile; drug showing various side effects and toxicities due to systemic accumulation in the body, and worse conformity from patient. Delivering modified drugs through using “polymer platforms” can help to overcome these issues along with enhancing the efficiency **[5]**. Several new technological therapeutics show low solubility and permeability through GI mucosa, and instability in the lumen is the three most important reasons for the poor oral bioavailability of these drugs. This limitation can be overcome by using the emerging platform for drug delivery like new nanoparticles containing multiple therapeutics, microencapsulation techniques, mucoadhesive techniques, or using “penetration enhancers”. PK research is crucial for producing and distributing oral drugs and helped the idea of drug design specifically to fulfil the needs of each person. This framework is based on the observation that persons are difficult to categorise because “somatic, gender, and/or genetic variables” cause heterogeneity in pharmacological treatment outcomes. As a result, tailored drugs are increasingly sought after to boost the effectiveness of a course of therapy and lower the likelihood of undesirable side effects. An oral delivery platform needs to address the quality of the therapy as well as the length of the treatment to be effective. The effective treatment of several illnesses through pharmacological therapy contributes to the annual improvement in life expectancy. The result is an ageing population with elderly individuals taking many drugs concurrently since they have multiple ailments. For this particular group, medication errors, missed doses, unanticipated drug interactions, or incorrect drug delivery methods might compromise the effectiveness and wellbeing of the therapy. In this regard, the introduction of a "polypill," or a system integrating many drugs in one dosage form would be advantageous to the patients to streamline and personalize the dosing routine **[6]**. Inhalation platform drug delivery system can improve the “pharmacokinetic profile” of the drugs and enables the submission of the lungs to the medications for a longer duration of time in a controlled manner when compared to “inhaled oral drug administration”. The drugs “biocompatibility” and safety in the specific area have been improved by the use of an inhalation platform drug delivery system **[7]**.

ADVANTAGES OF PLATFORM DRUG DELIVERY SYSTEM

To address several treatment issues that clinicians are now encountering, platform technology enables the adjustment of the delivery system from "one-drug-one-target" to "combination of drugs-multi-target" methods. Many drug combinations have been successfully discovered through *in vitro* testing. It is also possible to successfully synthesise several therapies into a single drug delivery system. Drug release rate and the burst release are highly controllable due to

the architecture of the polymer platform techniques. Platform drug delivery systems have shown targeted drug release by encapsulation using different types of polymers as a platform with a variety of drugs i.e. "chemotypes, including biological, small molecule, and cytotoxic drugs" **[8]**. Platform techniques improve the adherence of the delivery system to the "mucin/epithelial surface of the GI tract" which leads to significant improvement in the oral delivery system and it overcomes the problem of short gastrointestinal time **[9]**.To increase patient acceptance while retaining safety, effectiveness, accessibility, and cost, platform technology is necessary to support the development of age-appropriate medicines. Platform techniques deliver the drug locally or systemically for a specific period at a predetermined rate. This novel technique reduces drug accumulation in the body with useful application in chronic therapy. The development of new drugs is expensive and time-consuming, but platform-based drug delivery of modified existing drugs results in improved drug permeability from biological membranes and aids in the solubilisation of practically insoluble drugs, and this modified drug delivery consume less cost for both patients and professionals of the healthcare sector.

NOVEL PLATFORM DRUG DELIVERY SYSTEMS

Delivery system of "oral drugs"

Oral drug administration is among the leading and widely utilised drug delivery methods because it is more convenient, and economical, and results in higher patient compliance. The oral route is challenging because elderly and paediatric patients have difficulty in swallowing and have a fear of choking, and the bioavailability and, ultimately, the solubility of drug molecules determine how well a drug works orally. The research focused on the pharmacokinetic parameter (Dissolution), patient convenience, and compliance has encouraged this specific method for distributing drugs which is a safer technology.

i. Nanoemulsion: A Novel Platform for "oral drug Delivery System" or ODDS

The main aim of the "drug delivery systems" or DDS is to upgrade and enhance the usage while reducing the toxicity of drug molecules. One of the best examples of oral platform drug delivery is nanoemulsions **[10]**. A nanoemulsion consists of a surfactant molecule-based interfacial coating that stabilises the "thermodynamically stable", "isotropically transparent dispersion of two immiscible liquids". Nanoemulsions have consistent and micro sized droplets that sizes 20 to 200 nm. This technique is intended to address several issues with traditional drug delivery systems, including poor bioavailability and noncompliance **[11].** The platform nanoemulsion approach was designed to enhance the despersibility and vocal excretion of Amlodipine besylate and to enable targeted drug administration. The studied formulation revealed the emancipation of medicines from nanoemulsion was considerably greater "($p < 0.01$)" than the marketed formulation of tablets. Nanoemulsion of Amlodipine exhibited a significant increase in the total

load time at the targeted site, enhancing the effectiveness of the nanosized formulation at therapeutic sites **[12]**.

ii. "Self-microemulsifying oral drug delivery platform" (SMEDDS):

The area of SMEDDS platforms has recently seen advancements in "micro- and nanosystems for drug administration" **[13]**. The term SMEDDS refers to an isotropic system with lipid, surfactant, and cosurfactant that, with slight agitation, forms a combination in the "aqueous fluid". Around half of recently developed new chemical entities exhibit poorer aqueous solubility, which is a serious problem for the effective distribution of "therapeutic molecules" and therefore lowers the excretion of these substances. SMEDDS is regarded as the most important platform for addressing oral bioavailability issues of hydrophobic drug molecules. However, typical SMEDDS which have been generated by utilising a liquid substance may have a few drawbacks including "*in vivo"* "bioactive molecule precipitation", issues with product shipping, and limited apathetic transport. Therapeutic drug administrations approaches today are still few and loaded with side effects. Poor water solubility and bioavailability problems are also associated with certain drugs. As a result, the majority of drugs are developed via SMEDDS, which when used in *vivo* produces nanosize emulsion droplets **[14].**A natural compound Ferulic acid (FA) is used to treat insomnia. However, due to its low oral bioavailability and extremely fast elimination, its usage is restricted. SMEDDS was developed by the authors to increase FA's hypnotic potency and oral administration. After being developed, FA-SMEDDS morphology and storage stability was assessed. Additionally, pharmacokinetic and tissue distribution tests on rats were performed using a developed formulation. In mice with insomnia caused by p-chlorophenylalanine, the hypnotic effect of FA-SMEDDS was assessed. SMEDDS with FA put on them showed good stability and small (15.24 nm) droplet size. FA-SMEDDS has a relevantly significant digestibility of 185.96% after oral administration. In addition, SMEDDS dramatically reduced FA's metabolic conversion in the renal, decreasing the delivery rate of FA "from 76.1% to 59.4%", which indicates a decrease in renal expulsion. FA-SMEDDS demonstrated a greater impact in the cerebrum and increased "serotonin levels", extending sleep in mice with insomnia by twofold. This study demonstrated that FA-loaded SMEDDS increased "oral bioavailability", enhanced distribution in brain, decreased renal clearance and improved "hypnotic efficacy". As a result, it has been shown that SMEDDS is a potential carrier that may be used to enhance FA oral administration and expedite the development of products to treat insomnia **[15]**.

iii. "Nasal drug delivery system" or NDDS

The consideration of the nasal cavity as a route of drug administration, particularly for systemically acting drugs that provide a delivery issue, has recently gained interest of the pharmaceutical industry. For drugs which can only be administered intravenously, including vaccines and peptide and protein drugs, the nasal route offers a viable alternative approach. This method is also preferred for drugs experiencing a broad first-pass effect. Additionally, nasal drug

administration has been successfully used to penetrate the "blood-brain barrier" or BBB and deliver medication molecules to the "central nervous system" or CNS **[16]**.

The main drawback of NDD is "mucociliary clearance", which causes drug fragments to be cleared through the nasal part before fully absorbed. Although" nasal mucosa" provides improved excretion and "abrupt appearance" of action of the medication, this is offset by mucociliary clearance. Therefore, a mucoadhesive polymeric method can be employed to better retain the medicine on the "nasal mucosal surface". There are many polymers employed in nasal administration that are temperature-responsive, pH-responsive, and ion responsive **[16]**. As there is major "hepatic metabolism", the "dual serotonin" and "norepinephrine reuptake inhibitor duloxetine" (DLX) has a low excretion (40%). The bioavailability of the drug was shown to be improved during the formulation and assessment experiments of the DLX intranasal temperature reversible cubosomal gels, and the investigations ensure effective brain targeting. The intranasal platform DLX in "situ Cubo gel" has indicated to a 1.96-fold increase in brain solubility compared to the "intranasal solution" after in "vivo bio-distribution" testing in plasma and cerebrum. "Intranasal DLX" in "situ Cubo-gel" is an unusual nano-carrier delivery method for improving DLX solubility and targeting the cerebrum to optimise its effects **[17].**

iv. Transdermal drug delivery system or TDDDS

With the development of new and more effective medicinal treatments, the technology for drug distribution is becoming crucial. Topical formulations are desirable substitutes for oral formulations and have several benefits, including avoiding the stomach and first-pass hepatic metabolism. The primary barrier aspect of the skin, which limits molecular absorption, prevents drug transport over the skin (transdermal). There are now a variety of polymeric substances available for drug distribution across the skin. While "agro-polymers" like "polysaccharides", "proteins", and "lipids" have a crucial impact on biocompatibility, type of material, and range of substances, synthetic polymers like "polyesters", "polyamides", "polyurethanes", and "poly(ortho-esters)" provides opportunity to reproduce synthesis, several raw materials, and environment-friendly substances **[18]**. E.g. Conventional injections have a negative impact on microscopic patches, which are extremely promising platforms for transdermal drug delivery. On the other hand, microneedle arrays may be used to execute a broad variety of pharmacological medicines, from rapid vocal administration to sustained distribution of drugs (MNAs). Despite being thinner than traditional needles, "smart polymer-based MNAs" can be employed for "transdermal drug delivery" to the desired area of the patient's body. Inexpensive and simple methods may be used to fabricate 3D MNAs using additive manufacturing or 3D printing technology. They may be utilised for a wide variety of "diagnostic and therapeutic agents", from a blood sample for early disease investigation to medication and vaccination injections, and they are particularly developed for painless injections **[19]**.

v. Parenterals

Most active pharmaceutical compounds discovered through discovery screening procedures have limited water solubility. Because of their numerous articulation associated issues, such as worse bioavailability, lack of proper dose scale, slow beginning of action, and other characteristics that contribute to inefficient abidance of patients, these particles are frequently challenging to produce using regular methods. Additionally, because these compounds are typically delivered with co-solvents in parenteral preparations, they frequently cause negative side effects. Designing effective polymeric drug delivery nanoplatforms requires taking into account “active drug targeting” and controlled drug release of “hydrophilic macromolecular medicines”. The most efficient and popular method of delivery for active medicinal compounds with low bioavailability and drugs with a limited therapeutic index is parenteral administration.

The methods for shipping drugs which can reduce the amount of injections required over the course of the drug therapy are crucial not only for adherence, but also to raise the standard of care and perhaps lower the dose frequency. The adoption of particular formulation technologies that ensure the release of the active therapeutic material in a delayed and controlled way allows for this reduction in the frequency of drug administration. In recent years, the production of “novel injectable drug delivery systems” or NIDDS has drawn a lot of interest. Parenteral drug delivery has seen several technical developments that have led to the generation of complex practices that enable “drug targeting” and the "sustained or regulated release of parenteral drugs”. As “parenteral depot systems”, “biodegradable injectable in situ forming” devices for shipping drugs are a desirable substitute for microspheres and implants. As more proteins are wasting the “patent protection”, in the near future their significance will increase. The extent of patent of protein drugs may be increased by using these devices, which may also present appealing options for protein administration. There are several benefits to the controlled launch of “bioactive macromolecules” using “(semi-)solid in situ forming systems”, including simplicity of authority, less difficult manufacturing, and less demanding production conditions for sensitive drug materials. These factors have influenced the production of many “polymeric drug delivery systems” or PDDS that can create a “drug reservoir” at the area for injection **[20]**.

FLOATING FILM PLATFORM DRUG DELIVERY

Drug delivery systems using floating film platforms have become a cutting-edge alternative to conventional dosage forms including tablets, capsules, and liquids. Drug-loaded polymeric films made using the floating film platform technology are primarily made of active pharmaceutical ingredients, polymers, film-forming agents, and plasticizers with the appropriate solvent. By lengthening the stomach residence duration and regulating the drug release, floating drug polymeric platforms enhance drug bioavailability and patient compliance. Numerous attempts have been made in recent years to get around obstacles including short gastric residence periods and unusually long gastric emptying times.

The development of several floating delivery systems to optimise the distribution of molecules with narrow absorption windows, limited bioavailability, and significant first-pass metabolism is a result of delivery technology improvement. Pharmaceutical researchers from all across the world are investigating "thin films" as a cutting-edge DDS. "Thin films" have been regarded as a replacement option to traditional dose forms in floating film technology. The thin films offer a flexible platform for drug administration since they are easy to swallow, self-administrable, and have a rapid onset of action. This delivery technique has been applied via a variety of routes, including vocal, "buccal", "sublingual", "ocular", and "transdermal", providing both systemic and local action. The development of effective "thin films" demands a full knowledge of the medical characteristics of medicines and polymers together with a suitable selection of production procedures. It distinguishes itself as being superior to currently used conventional dosage forms in terms of improved digestibility, high conformity of patients, and "patent extension of active pharmaceutical components" (API). Additionally, "thin film" productions provide various benefits, such as (a) accurate administration via intra-operative methods, (b) simplicity in manufacturing and shipping, and (c) low cost formulation manufacturing **[21]**.

CLINICAL ADVANTAGES OF FLOATING FILM PLATFORM TECHNOLOGY

Due to its simple administration and appellative nature, a thin film is preferred by customers. Since it is simple to apply and reduces the issue of suffocating, "oral dissolving film" is extremely helpful for" paediatric", "geriatric", and "psychiatric" sufferers, ensuring patient safety. Drug retention time has been known to be increased by floating films, and drug absorption from the anterior part of the eye has been improved. The polymeric floating films, which may be supplied effortlessly and are seldom ever spit out, can also be helpful for bedridden and uncooperative patients. When a quick beginning of practice is necessary, such as in the case of "motion sickness", allergic reaction or coughing, "bronchitis", or asthma, a thin film can be helpful **[22]**.

POLYMERS USED IN PLATFORM TECHNOLOGY

Following is the summary of polymers used in platform technology.

Table 1: Summary of polymers utilised in platform technology

Sr. No	**Polymer**	**Physicho chemical properties/other information**	**Applications**	**Ref**
1	"Hydroxypropyl methylcellulose (HPMC)"	✓ These are "white, creamy, odourless, and tasteless powder" ✓ "Mw: 10,000–1,500,000"	✓ Film former (2–20%) ✓ Controlled and/or delayed-release polymer ✓ "Initial burst drug	

		✓ Additionally, these are "soluble in cold water, but insoluble in chloroform and ethanol" ✓ "Viscosity (η) 3–100,000 mPa· s" ✓ "Non-ionic polymer"	release followed by sustained drug release in buccal bio adhesive system of nicotine hydrogen tartrate"	**[23]**
2	"Poly (glycolic acid), poly (lactic acid), and hyaluronic acid"	✓ "Glycolic acid" is used as a monomer for the synthesis of polyglycolic acid and other biocompatible copolymers.	✓ Topical application ✓ In cosmetics to adjust acidity ✓ Disinfectant and keratolytic	**[24]**
3	"Poly(2-hydroxyethyl methacrylate) [Poly (PHEMA)]"	✓ Forms a hydrogel in water ✓ "hydrophilicity of poly (HEMA) confers resistance to protein fouling, making it a strong coating material for ventricular catheters"	✓ In synthesis of intraocular lens material and biomedical implant.	**[25]**
4	"Carboxymethyl cellulose (CMC)"	✓ It is a white powder with odourless texture ✓ "Mw: 90,000–700,000" ✓ High swelling and bio adhesive properties	✓ In bio adhesive drug delivery systems ✓ Modified CMC extensively used as film former	**[26]**
5	"Hydroxypropyl cellulose (HPC)"	✓ This is "white to slightly yellow odourless, tasteless powder" ✓ "Mw: 50,000–1,250,000" ✓ Soluble absolute ethanol, methanol, and propylene glycol	✓ Good film former ✓ In bio adhesive drug delivery systems ✓ Replaces synthetic polymers like HPMC with improved solubility	**[27]**
6	"Poly(N-isopropyl acrylamide)"	✓ Aqueous solution indicates a significantly lower temperature of the solution (LCST). ✓ "Temperature-responsive polymer."	✓ In stimuli and temperature responsive nanoparticle preparation for cancer treatment	**[28]**
7	"Poly (vinyl pyrrolidone)	✓ It have a wide range of "bioavailability"	✓ "PVP-HPMC" upgrades "film forming"	**[29]**

	(PVP)"	✓ "Non-ionic" ✓ "High swelling properties" ✓ "Co-adjuvant to increase mucoadhesion"	capability ✓ PVP-alginate blends utilised in controlled drug delivery applications ✓ PVP-EC and HPC blends produces more flexible, softer films	
8	Chitosan	✓ White, creamy, odourless powder ✓ "Sparingly soluble in water, insoluble in organic solvents and at alkali pH" ✓ Soluble in acidic pH	✓ Excellent bio adhesive and film forming property ✓ Controlled drug release applications ✓ Enhances transport of polar drugs through epithelial lining	**[30]**
9	Sodium alginate	✓ White or buff odourless, tasteless powder ✓ "Insoluble organic solvents and acids where the pH of the resulting solution falls below 3.0" ✓ Viscosity: "20–400 Cps" Safe, biodegradable and non-allergenic	✓ Excellent gelling property ✓ Anionic in nature with excellent bio adhesive property ✓ Applied in controlled drug release systems	**[31]**

CHALLENGES ASSOCIATED WITH THE PLATFORM DRUG DELIVERY SYSTEM

Various polymeric materials are used to develop novel platform drug delivery dosage forms. Although few aspects of "pre-clinical" and "*in vivo"* models have been documented, conformational transformations of "biomaterials" in response to "environmental stimuli" have made the process of drug launch in typical "polymeric systems" more complicated **[32]**. For semi-industrial scale manufacturing, these conflicts and the design of specialised alignment of "polymeric systems" comes with certain difficulties. Additionally, in certain circumstances, limited biocompatibility, low degradability, and toxicity hinder polymeric systems from having the potential to receive FDA certification and clinical clearance **[33]**. The advancement and facilitation of various types of alternative therapies to enhance traditional treatments are made possible by the use of polymeric platforms in conventional drugs and nanomedicine. The formation of drug distribution mediums based on "polymer materials" may be the strategy utilised the most frequently in alternative medicine **[34]**. This kind of cutting-edge platform technique with a variety of features might pave the way for further promising developments in

the standard of DDSs and "underlying therapy practices". Utilizing stimuli-responsive materials and techniques is one of the newest ideas in alternative medicine, particularly in the context of drug release systems. Indeed, these platform techniques may be crucial to the success of extracellular drug administration and targeted drug delivery **[35]**. Researchers are now concentrating on developing a different platform-based technology employing polymer that might regulate the programmed drug release. Researchers might create unique DDS that allow for drug release control at a specific time and tissue by applying this technique. With this kind of method, the drug release may be regulated over an extended period. In the future, more efficient products will be due to contractual to the advancement of platform technology based on polymers. This is made feasible by being aware of these polymers' capabilities and constraints in diverse applications, including DDSs. The chemical and molecular properties of the polymer have a role in polymeric-based drug delivery. Indeed, the output in the development of DDSs may be influenced by species selectivity, polymer shape, and particle size **[36]**. These elements may be changed and managed to become a viable platform for the development of DDSs. "Low-molecular-weight biodegradable polymers" containing "hydrophilic groups" may be necessary, for instance, when fast drug launch and polymer humiliation are taken into account following total drug depletion .e.g. For several areas of medicine, including "targeted medicine delivery", dressings for treatment, and "antimicrobial medical coatings", non-biodegradable polymeric particles are utilised. However, employing these materials has adverse effects such as long-term toxicity and inflammatory responses. Using "biocompatible substances" with humiliating characteristics is a result of these adverse effects. Due to the unique "drug reseale approach" and improved biometricity, dissolving and ecological polymeric materials have been offered as appropriate alternatives to non-ecological polymeric equivalents in "nanomedicine" based on their low toxicity **[37]**. "Nitric oxide" that is released to "coagulate blood vessels" and increase the rate of blood flow to the wounded region. Enhancing the percentage of "oxygen-rich blood" in the wound increases the development of healthy tissue.

FUTURE PERSPECTIVE OF PLATFORM BASED DRUG DELIVERY RESEARCH

The delivery systems, synthesis methods, and potential substances for enhancing the solubility, bio absorbability, and "therapeutic index" of medicines have made significant advancements in the last few years in novel DDS. A large number of currently available prescribed medicines have undesirable "physicochemical" and "pharmacokinetic" characteristics, as well as several restrictions on dosage regimens and undesirable impacts in the traditional dosage form. For improving these therapeutic indices and lowering adverse effects, the development of "novel polymer-based drug distribution mediums" and production would be prospective and promising techniques. However, since the clinical implementation should be the final goal of a study, it should not be ignored to balance drug ability and "functional design". There wouldn't be any innovative medical preparations without technological up gradation, as decades of experiment and knowledge in drug R&D has shown. It is crucial to advance the pharmaceutical industry's

research and development of cutting-edge polymer platform technologies. As a result of extensive testing, revision, and optimization, an authentic technical experiment unquestionably develops into an innovative technology for use in drug delivery systems.

One of the most interesting fields of study at the moment is “nanomedicine”. Several research have been conducted in this specific area in past decades and the outcomes have influenced the filing of 1500 patents and the accomplishment of several medical trials. The major example of a condition where non-medical platform technologies have influence “diagnosis and treatment” is cancer, it seems. Using “nanomedicine” and “nano-drug delivery systems” is having become an efficient trend that will expand in future research. This is because they allow for the accurate delivery of drugs to diseased cells, such as cancerous or tumor cells, without altering the “physiology of other cells”.

Examples of “nanoparticles” included in this communication are not connected in size, with some ranging in “nanometres” and others in “sub-micrometers (over 100 nm)”. The future area of research would be the advanced study of substances with more consistent connection and “drug loading” and release potential. The future research will also include a significant degree of advancement in the usage of “metals-based nanoparticles” for treatment purposes. Future study on the use of these metals, especially gold and silver, in both diagnosis and therapy has influenced the expansion of using “nanomedicines”. There have been several formulation and biomaterials studies, which appear to represent the early procedures of “biomedicine applications”. “Animal experiments” and multidisciplinary research, which consumes huge time and money, can provide relevant data which will be useful in “drug therapeutic” and “diagnostic experiments”. The future for a more intelligent and multi-centered approach to the polymer platform drug delivery technology appears bright with the rising worldwide tendency to search for more precise treatments and diagnoses. Platform technology's capability can be another efficient topic to study that would require additional research contributions as it gained popularity **[21]**.

CONCLUSION

Platform technology can accommodate pharmaceuticals with similar physicochemical and therapeutic qualities while requiring little modification. It consists of a polymeric system with a release modulator. Pharmaceutical industries are experiencing a tremendous rise in the growth and progress of “polymeric drug distribution technologies” based on both “natural and synthetic polymers”. To increase patient acceptance while retaining safety, effectiveness, accessibility, and cost, platform technology is necessary to support the development of age-appropriate medicines. Platform techniques deliver the drug locally or systemically for a specific period at a predetermined rate. Nanoemulsions, SMEDDS, nasal DDS, TDDDS, floating DDS, and parenteral formulations are some of the popular and NPDDS widely utilised in the medical industry due to the most convenient, economical, and high patient compliance.

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