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The Ideal Drug Concept and Nanotechnology's Potential to Realize It

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Abstract

Drug research is a field of research that has significantly contributed to the advancement of medical sciences, and enhancing drug qualities in terms of many expected properties is still a challenge and goal for these researchers. Though the purpose of drug research is to continuously enhance current pharmaceuticals in terms of their curative potential and to discover new treatments with significantly increased capacities to heal many existing and new diseases, the ultimate goal of drug research is to identify one drug that can cure all diseases. The perfect medication or ideal medicine is a drug system that can treat any condition instantly. A systematic research on the objective of perfect drug discovery has yet to be formed based on the exact property expectations from a drug system as a treatment to heal all ailments. In this study, we attempted to determine the features of a perfect medication capable of curing all ailments in the universe. We also reviewed the constraints and potential for developing such a perfect medicine that can treat all ailments. We also considered the use of nanotechnology, which is emerging as a universal technology, to actualize the prospect of making a perfect medication in practise. The advantages, benefits, limits, and downsides of adopting nanotechnology in drug research to improve drug systems are also highlighted. Finally, in terms of Ideal System Characteristics, a comparison is made between traditional medications and nanotechnology-based pharmaceuticals.

Keywords: *Drug, Ideal Drug, Ideal Drug characteristics, Pharmaceutical Sciences, Nanotechnology, Nanomedicine.*

INTRODUCTION

A drug is a chemical substance composed of numerous components acquired naturally or synthetically that affects human/animal physiological activities. A medicine is used to diagnose, cure, treat, prevent, or relieve some form of discomfort in many diseases, and the treatment process is known as drug therapy. The area of pharmacology is concerned with the continuous progress of pharmaceuticals, whereas the field of pharmacy is concerned with the right administration of drugs.

Every medicine interacts with the human body or any living system via chemical processes and can be activated by two basic mechanisms: stimulating or inhibiting regular physiological functions, and binding to regulatory molecules. The medicine molecules normally cause diverse chemical responses in the patient by interfering with some undesirable process known as Therapeutic Effects. It also has toxic properties, which parasites employ on their hosts.

As a result, every medication can function as both an agonist and an antagonist. An agonist medication activates or enhances the action of a certain regulatory system or bodily function. An antagonist drug works as an inhibitor, acting in the opposite way as the agonist. The following are the three general qualities of an effective pharmacological drug:

- The drug should have specific molecular size, shape, and charge to interact with the receptor.
- The drug molecule should able to travel to its site of action from its location of administration.
- The drug must be easily excreted from the body once it completes its action.

Aside from the main physical attributes listed above, a medicine should have certain extra desirable characteristics such as efficacy in response, safety for the living organism, and selectivity in action. If the medicine does not provide an effective reaction, it should not be utilised. There is no such thing as a medicine that is safe for the live body. All medications are harmful, either directly or indirectly. Because all medications might induce adverse effects, there is currently no drug that is totally selective.

Thus effectiveness, safety, and selectivity of drug action are the challenges of drug research. Drug research is considered as a very important research area and probably found more investments of resources and time during the last few centuries. Drug research also contributed to the progress of medical sciences substantially and improving characteristics of drugs in terms of various predicted properties is continued as a challenge and agenda of these researches. Focus on new drug discovery which has better properties towards achieving improvements in effectiveness, safety, and selectivity is the drug research agenda of many pharmaceutics research laboratories around the world. In order to further intensify the objectives of drug research, in this paper, we have predicted the characteristics expected in a hypothetical drug called ideal drug and also discussed the possibility of realizing such ideal drug in practice.

IDEAL SYSTEMS RESEARCH

The word _Ideal system‘refers to the system which has ideal characteristics i.e., perfect in every way. The concept of ideal engine, ideal switch, ideal semiconductor devices like ideal diodes, transistors, etc. have been defined, studied and taken as standards to improve the quality and performance of such practical devices or systems. It is expected that, by keeping such a hypothetical device or systems in mind, researchers have continuously improved the characteristics/properties of practical devices / systems to upgrade their performances. Hence ideal properties of a device or a system can be used to upgrade or improve its properties towards reaching 100% efficiency. By comparing the properties/characteristics of a practical device/system with its ideal system counterpart, it is possible to modify the device /system towards reaching the objective of achieving such an ideal device. It is clear that ideal systems are hypothetical systems, which cannot be realized completely in practice but they give a broad idea on how the practical systems can be improved continuously to reach ideal system characteristics. The ideal system characteristics of ideal technology, ideal business, ideal water purifier, ideal education, ideal banking, ideal electrical energy, ideal software, ideal computing,ideal library system and ideal strategy [18], are discussed under input characteristics, system characteristics, output characteristics, and external characteristics shows an opportunity to the scientists and engineers to improve such practical systems further with an objective to reach the goal. Based

on the review, we have also discussed the possible characteristics of some of the future anticipated systems like ideal automobiles, ideal home, ideal human being, ideal organization, ideal city, and even, ideal world.

OBJECTIVES OF THE STUDY

This paper is conceptual in nature and uses predictive analysis methodology to build a model and analyse it. The objectives of the paper are as follows :

- To formulate a method to improve the performance of drugs by knowing the objectives of drug research.
- To study the characteristics of the ideal drug by considering it as an ideal system. To discuss the characteristics of the ideal drug in detail using ideal system model. To analyse the possibility of realising ideal drug in practice.
- To investigate the possibility of realising ideal drug using nanotechnology &nano-biotechnology.
- To compare the ideal drug characteristics with predicted nanotechnology-based drugs.
- To predict a timeline to achieve the expected solutions.

IDEAL DRUG SYSTEM MODEL

The objective of drug research is continuous improvements of existing drugs in terms of their curing ability and to discover new drugs which have substantial improved abilities to cure many existing and new diseases and the final goal of drug research is directed to identifying one drug which has the ability to cure all diseases. All research work in pharmaceutics is directed towards improving drug properties including their effectiveness, safety, selectivity,no side effects, cost, accessibility, time of cure, etc. The ideal drug is a material which shows ideal characteristics. According to ideal drug model it is a system which operates on other systems based on its own properties and these properties are divided into input characteristics, operational characteristics, output characteristics, and environmental characteristics. Based on various factors which decides the ideal drug system characteristics, a model consisting of input conditions, output conditions, environmental conditions and system requirements are derived by a qualitative data collection instrument namely focus group method. The block diagram of such ideal drug system is shown in Figure 1. The expected characteristics of ideal drug under these categories are listed below :

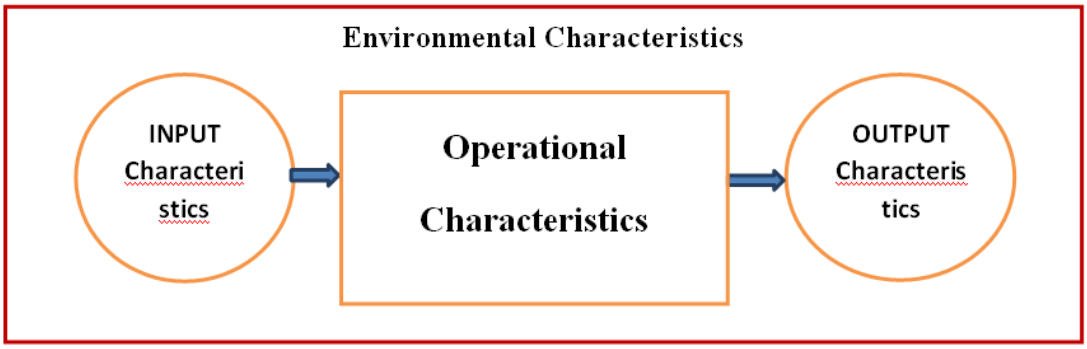

Fig. 1 : System model representation of Ideal drug in terms of its characteristics

(a) Input Characteristics :

1. Ideal drug can have any type of physical state.
2. Ideal drug independent on dosage.
3. Ideal drug is a scalable system.
4. Ideal drug is affordability for patients in terms of material usage.
5. Ingredients used in ideal drug are abundant and freely available to everybody.

(b) System/Process Characteristics:

1. Ideal drug should be non-toxic, biocompatible, and biodegradable.
2. Ideal drug has no side effects.
3. Ideal drug shows the selectivity in its action.
4. Rate of ideal drug release is instantaneous and controllable.
5. In ideal drug, the drug release has no relationship with the drug action.
6. Ideal drug release is as per required therapeutic amount.
7. No carrier is required to take ideal drug to reaction site.
8. The delivery system for ideal drug should be easy, simple, and cost effective.
9. The ideal drug should be easily eliminated from the body by simple metabolic processes after its action.
10. The ideal drug will not get accumulated in any part of the body causing inflammation.
11. Ideal drug is 100 % effective in curing the disease.
12. Ideal drug is100 % safe for the living body.

(c) Output Characteristics:

1. Ideal drug cures the disease completely.
2. Ideal dug cures diseases immediately.
3. Ideal drug produces no by-products.
4. No repetition of same disease again.
5. No therapies and rest required after recovery.

(d) Environmental Characteristics

1. No side effects so that it should be safe for users, and environment.
2. No environmental harm and degradation.
3. Location independence.
4. Solutions to all types of health problems.

Ideal drug cures every disease of every living human beings & animals and hence decreases mortality. The ideal drug also helps to regenerate human organs where ever necessary. Hence it is expected that this hypothetical drug solves all health problems in the society.

DESCRIPTIONS OF IDEAL DRUG MODEL:

New drugs are designed and discovered by many scientists belonging to the subject called pharmaceutics. Pharmaceutics is the subject of pharmacy that deals with the process of discovering a new drug or old drugs into a new drug used by patients for curing their disease safely and effectively.

The listed characteristics of ideal drug are further described below:

(a) Input Characteristics:

1. Ideal drug can have any type of physical state: The physical state of an ideal drug can be solid, liquid, or gases and the physical state of the drug is not a constraint for feeding it to the living body as medicine.

2. Ideal drug independent on dosage

The action and effect of the ideal drug are independent on the dosage. Whatever the quantity of drug is fed to the body will able to selectively cure the disease. In practice dosage increases with an increase in drug quantity and an optimum dosage is required to cure a particular disease of particular gravity.

3. Scalable system

Ideal drug is a scalable system and can be used for zero to infinite number of dosages to any number of patients. Practical drug systems have limited capacity in terms of dosage and scalability.

4. Affordability in terms of material usage for Ideal Drug

The materials used for the preparation of an ideal drug should be freely available in nature. The cost of an ideal drug should be zero so that everybody can afford for it.

5. Ingredients used are abundant and freely available to everybody

The ingredients used for the preparation of ideal drug are freely and abundantly available in all parts of the universe so that

every living being has equal access to such ingredients to prepare the drug irrespective of their physical location.

(b) System/Process Characteristics:

(1) Ideal drug should be non-toxic, biocompatible, and biodegradable

It is believed that all practical drugs are toxic for one or other organs of the living body. Drug reactions are of two types as allergic and toxic. Allergic drug reactions are independent on the dose of medication and are unpredictable.

Toxic reactions occur in the body when there is an accumulated of too much drug in the bloodstream which leads to adverse effects on the body. Ideal drug by its definition does not be toxic to the body due to its nature of biocompatible and biodegradable. Biodegradation refers to the process by which the drug delivery system is broken down inside the body.

(2) Ideal drug has no side effects:

All practical drugs come with side effects. Some side effects are just an inconvenience, some are minor, a few are serious, and a few are just plain strange. Many drugs produce an allergic reaction which can range from itchingand rash to even a life-threatening anaphylactic reaction. But as per the definition, the hypothetical ideal drug is free from all kinds of side effects.

(3) Ideal drug shows the selectivity in itsaction:

Restrict drug distribution to target cells or tissues or organs only and should have uniform capillary distribution. The ideal drug is highly specific in activity in identifying and curing the diseases. It also works with only diseased cells or organs and acts on it to cure the disease completely.

(4) Rate of ideal drug release is instantaneous and controllable

Drug release is an important property of a therapeutic system, constituting a prerequisite to absorption of the therapeutic agent and one that contributes to the rate and extent of active availability to the body.

When placed in a release medium, the agent that has to diffuse to the surface of the membrane for release immediately. In the case of an ideal drug, it is assumed that drug release is instantaneous and controllable, biodegradation occurs immediately through diffusion or dissolution.

(5) In ideal drug, the drug release has no relationship with the drug action

In pharmacology, the drug action refers to the biochemical interaction with the specific molecular targets to which the drug binds, such as an enzyme or receptor. Drug release is an important property of a therapeutic system, constituting a prerequisite to absorption of the therapeutic agent and one that contributes to the rate and extent of active availability to the body. In case of an ideal drug, the drug release is instantaneous and has no relationship with the drug action.

(6) Ideal drug release is as per required therapeutic amount

Since drug release is an important property of a therapeutic system in curing the diseases, it should be instantaneous and as per the requirement of the therapeutic amount in the releasing region. In case of practical drug release, there is no perfect equilibrium between optimum drug requirement in curing region and the drug release. But as per definition, in case of an ideal drug, the drug release amount is as per therapeutic requirement.

(7) No carrier is required to take an ideal drug to reaction site:

Ideal drug identifies its destination itself, i.e., its reaction site automatically and hence no carrier is required. Drug carrier is a material used along with the drug and is works to manage the drug release in a systematic circulation so that the selectivity, safety, and effectiveness of the drug can be improved. In case of an ideal drug, the drug itself identifies its destination so that no separate carrier is required.

(8) The delivery system for the ideal drug should be easy, simple, and cost effective

Drug delivery is the method of administering a drug to achieve a therapeutic effect in a systematic manner. In practical drug delivery systems many concepts, methods, and techniques are used and together have been named as controlled release technology. Examples of controlled release technologies are transdermal and transmucosal controlled-release delivery systems, drug-impregnated lozenges, ml6 nasal and buccal aerosol sprays, encapsulated cells, iontophoretic devices to administer drugs through the skin, oral soft gels, and a variety of programmable, implanted drug-delivery devices . These technologies are technically complex and expensive for the common man. As per the definition of the ideal drug, the delivery system for the

ideal drug should be easy, simple, and cost effective.

(9) An ideal drug should be easily eliminated from the body by simple metabolic processes after its action :

Once the drug reaction is complete, the excess drug should be eliminated by a simple metabolic process so that there will be no side effects on any other cells or organs of the body. This is possible only in hypothetical ideal drug whereas, in conventional drugs, the side effect is due to the action of the drug with other regions/body parts which is unacceptable.

(10) The ideal drug will not get accumulated in any part of the body causing inflammation

Inflammation is a self defense mechanism of the human body to heal any damaged cells, irritants, and pathogens. It is a part of every body's immune response. Usually, during medication, the part of the drug leftover or access in the body may cause inflammation which is unnecessary. But in the case of an ideal drug, since there is no accumulation of drug in any part of the body, there is no possibility of causing inflammation.

(11) Ideal drug is 100 % effective in curing the disease

All drugs are not equally effective in curing diseases. But as per the definition, an ideal drug cures a disease completely and is 100 % effective.

(12) Ideal drug is100 % safe for the living bod

Since the ideal drug is not showing any side effect due to its peculiar property of selectivity and noninflammability, it is completely safe to the living body.

(13) Ideal drug shows a broad spectrum of efficacy

Efficacy means the ability to produce a desired or intended result. Broad spectrum of efficacy means the ideal drug can fight against both Gram-positive and Gram-negative bacteria or virus to cure the diseases.

(c) Output Characteristics

(1) Ideal drug cures the disease completely

An ideal drug defined here has the property to cure a given disease completely. An ideal disease can cure one or more disease completely. As per the definition, an ideal drug should cure all the diseases completely in every living being.

(2) Ideal dug cures diseases immediately

The ideal drug defined here has property to cure a given disease instantaneously and completely. In case of the practical drugs, some of them may cure the diseases by killing or halting the spread of bacteria or viruses,some drugs may identify and kill cancerous cells in the body andsome other drugs may replace missing substances or hormones or vitamins.

(3) Ideal drug produces no by-products

Ideal drug is a hypothetical entity which does not produce any harmful by-products during the curing process. But the conventional drugs may produce adverse drug reactions in some living bodies due to the interaction of drug and its by-products with body cells.

(4) No repetition of the same disease again

As per our assumption, when the ideal drug is inhaled, it has the ability to cure the diseases instantaneously and the drug cures the disease in such a way that it will never appear again in that living being, i. e., no repetition of the same disease again.

(5) No therapies and rest required after recovery

Usually in practical drugs based curing, once the disease is cured the therapy should continue for some time for complete curing and during such time the patient is advised to take rest by the doctors. On the other hand, in the case of ideal drugs, no rest to the patient is required due to the fact that the disease completely cures instantaneously.

(d) Environmental Characteristics

(1)No side effects so that it should be safe for users, and environment :

The ideal drug acts only on diseased cells and does not produce any harmful chemical during its action so that it has no side effect and hence is assumed to be safe to the users and environment.

(2) No environmental degradation

Since the ideal drug is not producing any harmful chemical as the by-product, there is no excretion of harmful chemicals occurs from the body to the environment. As a result, the environment is not affected by the excreted drug discharge.

(3) Location independency

Ideal drug yields same result of complete curing of diseases in any location around the world and in any time after the disease is started. The geographical factors and physical factors like temperature and pressure will not affect the expected performance of the ideal drug.

(4) Solutions to all health problems

As per the definition of the ideal drug, it is always effective and gives quick solutions to any kind of diseases from a headache to cancer and hence solves all the health problems of living beings.

CHALLENGES & OPPORTUNITIES IN ACHIEVING IDEAL DRUG SYSTEM :

As mentioned earlier, the concept of the ideal drug is purely hypothetical and looks strange but it gives appropriate direction for future research. This model gives the idea of the required quality improvement of various properties of the drug in order to cure the diseases and the opportunities and challenges in future research. The ideal drug model sets the goal of every researcher to decide their objectives while choosing the research topic related to drug discovery.

(1) Opportunities

Ideal drug concept and characteristics based on the system model provides the following opportunities to drug researchers and drug manufacturers :

Improve the quality of the drug by setting new objectives.

Setting the target for the researchers to improve input, process, output, and environmental characteristics of the drugs.

Continuous improvement opportunity by planning and researching in anidentified characteristic.

Focused research on issues related to the effectiveness of the drug, safety to patients, selectivity in drug action, decreased side effects, low cost, wide accessibility, less time for the cure, etc.

To think on the realization of an Ideal drug with input characteristics like having any type of physical state, independent on dosage, scalability, affordability in terms of material usage for patients, and abundant and freely available ingredients usage. To also think and use the system process characteristics mentioned above while planning the drug discovery process.

Drug manufacturing companies get new opportunity to use this model to re-define their objectives and enhance their R & D activity along with R & D budget.

The consumers/patients also getthe opportunity to have access to improved drugs to cure their diseases.

(2) Challenges

Apart from opportunities, the ideal drug concept posses many challenges for drug researchers, drug manufacturers, patients,

health industry and even for the entire society. The individual characteristics under different headings like input, process, output, and environmental sections of the ideal drug system are really posing challenges for conventional thinkers and for the entire health industry. Converting these challenges into an opportunity to realize ideal characteristics of the drug atleast individually if not altogether is the new goal of the health science research. The following are some of the challenges for drug researchers and drug manufacturers :

- The researchers face new challenges in their attempt to realize the ideal drug characteristics.
- The challenge of developing a material to be used as an ingredient to realize ideal drug.
- Manufacturing the drug using such ingredients which can possess ideal drug characteristics.
- The challenge of convincing the drug manufacturing companies to invest in attempting to realize the ideal drugs.
- Challenge on handling heavy resistance to be observed from the health science & pharmacy community as they see it as a threat for their profession.

NANOTECHNOLOGY AS UNIVERSAL TECHNOLOGY :

Nanotechnology is expected as a technology of the 21st century to solve many problems of society both at primary and secondary level. Nanotechnology allows many fields of science and technologies to converge to single integrated technology and offers a new way to solve problems of society both at fundamental and applied levels. Such convergence ability of nanotechnology from many fields to single field leads to an increase in interdisciplinary research at the nanoscale. Many nanotechnology interdisciplinary groups for interdisciplinary research are formed in this century all over the world during recent years to accelerate the research and development in nanotechnology and related areas. Nanotechnology has solutions of many problems of agriculture to get nutritious food to every living being of the world, potable water for drinking and irrigation, renewable energy for essential human activities, many new and essential consumer durable systems, and better healthcare facilities. Nanotechnology is expected to change the definition and principle of functioning of many products and services provided by various industries to their customers as general purpose

technology [24]. It is expected that the effect of Nanotechnology (NT) along with another already matured technology called Information Communication and Computation Technology (ICCT) is enormous in future days in the society on lifestyle of human beings and these two technologies are expected to solve many problems and requirements of the society and hence named them as Universal Technologies. Being one of the Universal technologies, nanotechnology has huge hope in solving all the problems of living beings related to health sciences. Many problems in medical scienceshave already anticipated solutions at least at conceptual level using nanotechnology and ICCT. In the next section, we have discussed the anticipated breakthroughs of nanotechnology solutions in health and medical science problems and hence the possibility of realizing the ideal drug characteristics using nanobiotechnology in future years.

POSSIBILITY OF REALIZING IDEAL DRUG USING NANOTECHNOLOGY

Nanotechnology being a general-purpose technology of 21st century and growing as universal technology has solution in the process of developing ideal solutions to health and medical sciences problems. Nanotechnology is evolving as a new hope to create and utilization of materials and tools at nanometer scale and influencing number of industries in health and medical sciences including in particularly pharmaceutical industry.Nanotechnology tools and techniques developed for different industry sectors along with biotechnology ideas have potential opportunities in achieving ideal drug characteristics in pharmaceutical industry. It is also believed that nanotechnological tools suitable for improving the characteristics of drugs towards ideal drug are exotic, disruptive, and futuristic so that may take long time in terms of several hundred years for commercialization. Currently nanoparticles and nanodevices such as nanobiosensors and nanobiochips, are used to discover new drugs or to improve the characteristics of existing drug in pharmaceutical research industry.

This include

- Some nanosubstanceslike fullerenes are considered as potential drugs for the future healthcare industry.
- The nanoparticle based drug delivery systems allows to target drugs to specific areas of the body.
- The medical imaging technique is expected to utilize drug delivery systems to illuminate to any cellular

functions including tumors, or the brain in the body.

- The nano scale drug particles can reach inaccessible areas in the body such as inflamed tissues due to their improved permeability and retention effect.
- New nano-scale drug carriers are developed using dendrimers, to increase the possibility of increasing therapeutic index of drug molecules.
- The nanotechnology based long acting injectable therapies for HIV treatment. The nanomaterial based systems are used as carriers of antibiotics for infectious diseases.
- Various nanoparticles, and nanofibers and nanoporous scaffoldsare used in the fabrication scaffolds for nanoengineering scaffolds to replaced and re-grow damaged tissues and organs.
- Silica based mesoporous nanomaterials with surface reactive functionalities are used for bone tissue engineering.
- Use of nanomedicine for managing diabetics.

Based on such many possibilities discovered till now, there is a hope that many more diseases may find optimal curing solutions in future days using nanotechnology based techniques.

CONCLUSION

The ultimate goal of health science is the prevention and treatment of all forms of illnesses in living creatures, including humans. Disease prevention and treatment require an appropriate drug/medicine system. The medications now utilised to treat various diseases have several limitations and must be improved in terms of their capacity to totally cure the condition. In this study, we define a so-called ideal drug system that can assist researchers and decision makers in the pharmaceutical business in redefining their research and development objectives. The perfect medication or ideal medicine is a drug system that can treat any condition instantly. We attempted to find the features of an ideal medication that can treat all diseases in the universe based on the exact expectations of the properties of a drug system as a medicine to cure all diseases. We also reviewed the constraints and potential for developing such a perfect medicine that can treat all ailments. Furthermore, we examined the possibilities of employing nanotechnology, which is growing as a universal technology, to actualize the possibility of generating perfect drugs, and in this context, we examined some of the research agendas focused on curing various diseases using nanotechnology.

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