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Review Article

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Nanoparticles in the Treatment of Virus- A Broad Study

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ABSTRACT

Viruses impact on healthcare and socioeconomic development. In a public health care system drug resistance are currently are available different therapies. Adverse side effects due to prolonged use is a serious public health concern. Novel treatment strategies developed. The interactions of nanostructures with microorganisms is fast revolutionizing the biomedical field by offering advantages in both diagonostic and therapeutic applications. Nanoparticles have unique properties that can help in drug delivery. The properties of nanoparticles that depend on others are particle size distribution, surface to volume ratio and surface charge depend on encapsulation. This properties can make nanoparticle drug delivery systems to explore therapeutic effects. This review present how to treat viral infections with nanosized materials.

Keywords: Nanosized Materials; Liposomes; Micelles; Viral Infection; Gold Nanoparticles

INTRODUCTION

Infectious disease agents such as bacteria, viruses, fungi and parasites account for approximately 15 million deaths worldwide, with acute respiratory infection and human immunodeficiency virus (HIV) being the leading causes [1,2]. Viral infections can help in both health and socioeconomic development [3]. Drug resistance evolved as it is associated with HIV and influenza infection [4-8]. This phenomenon included morbidity and mortality added costs associated with the use of more expensive drugs and a greater burden to public health systems [2,9]. A novel method develop to treat viral infections.

Nanoparticles are particles that belong to the nanometer range [10,11]. The interaction between nanoscience and biological systems is known as nanobiotechnology [12,13]. It is associated with nanomedicine and diagnose, treatment and prevention of diseases [14].

We are going to introduce here dose limiting biocompatible drugs [15]. For its small size it can invade cell easily [11,16]. Large surface area to volume ratio, surface charge make it a strong weapon to treat viral infections [17,18,19]. Nanoparticles also have some anti-viral properties [20-24]. It also can act as dendrimers [25,26]. It can be able to formation of stable structure [27,28]. It can also modified the structure of polymers [29]. It can also increase stability and the drug retention times [30,31]. This nanoparticles can invade cell and act in the cellular components [30,31,32]. Nanoparticle act as a drug carrier in case of RNA system also. It will act as a carrier in the blood-brain barrier also. It leads to low level replication [33,34]. It also can invade the obstacle and act as a promising tool against membranes [35]. To invade all this problem RNA technology is necessary [36]. The inability of RNA to cross the cell membrane, due to large molecular weight and anionic charge rapid renal clearance, uptake by phagocytes, and toxicity due to stimulated immune response [37,38,39] all present limitations which prohibits their clinical utility. This review will provide an overview of the most recent and relevant literature that describes the application of nanotechnology for the treatment of common viral infections.

Biocompatible Systems

Organic nanoparticles

Organic nanoparticles are most common nanoparticle in drug delivery in humans [40-43]. The most common types of organic nanoparticles are presented below

Polymeric nanoparticles

Polymeric nanoparticles are particles ranging in size from 10-1000 nm. The small size result in capillary penetrations at target sites [44-49]. Polymers approved by the WHO and FDA use in medicine and pharmaceuticals include PLA, PGA and PLGA [50]. PLG and PLGA based nanoparticles are used for biocompatibility and biodegradability purposes [51]. It can interact with serum proteins decrease the opsonization [52,53]. The pharmacokinetic profile and gold-standard of cloaking agent systems can also be represented here [54,55]. Polymeric

nanoparticles can be classified as nanocapsules and nanospheres.

Figure 1: Polymeric Nanoparticle Shaped in Spherical Structure

Nanocapsules

In nanocapsules the drug get loaded in the hollow capsules of the inner cavity of polymer. This is coated by some coating range in size from 50 to 300 nm [56]. Nanocapsules can be used as an antiviral agents to cross blood brain barrier [33].

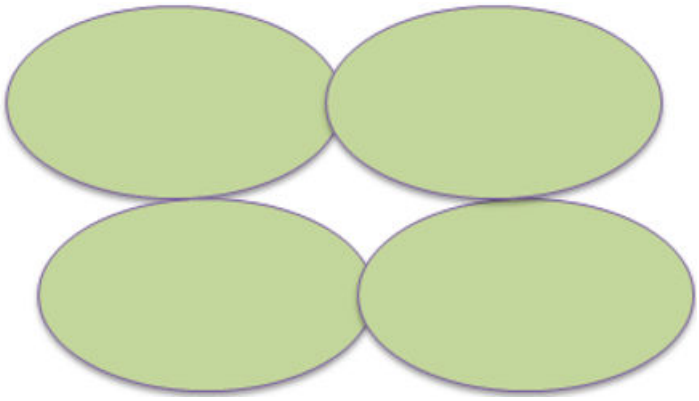

Figure 2: Structure of Nanocapsule

Nanospheres

Nanospheres are matrix that are uniformly dispersed within the size range of 100-200 nm in diameter [56,57]. Hepatitis B virus (HBV), herpes simplex virus (HSV) and influenza are treated by nanospheres [58-62].

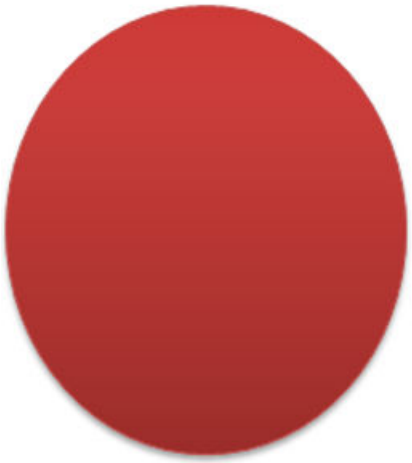

Figure 3: Structure of Nanosphere

Liposomes

Liposomes are spherical carriers ranging in size from 20-30 nm [63]. A phospholipid bilayer is there contain an aqueous core [64]. Hydrophilic and lipophilic drugs can also be incorporated into the phospholipid bilayer [65]. It can also be act as an immunological parts [66].

Micelles

Micelles are ranging in size from 10 -100 nm [57]. Polymeric micelles are working as drug delivery agents which have significant therapeutic potential [67-69]. Drug encapsulation with polymeric micelles is one of the most attractive nanotechnologies used to improve both the water solubility and stability of limited drugs [70].

Dendrimers

Dendrimers are symmetrical, macromolecular and hyper-branched structure having connectors and branching units that target environment is controlled by the terminal groups [71]. Central core, branches and functional groups can have the ability to display multivalent surface [72].

Sold Liipid Nanoparticles

Solid lipid nanoparticles are alternative drug delivery system to the conventional colloidal nanoparticles. It can also combine with other nanoparticles and uses in drug delivery systems. Large-scale production of polymeric nanoparticles is a major challenge, production is cost-effective [73]. Stability, safety, availability, decreased toxicity can improve drug-profiles in compared to synthetic polymer nanoparticles [74-76].

Inorganic Nanoparticles

Inorganic nanoparticles are smaller in size than organic nanoparticles [35]. The top-down approach uses chemical or physical methods to reduce the inorganic material to its nanosized form [77].

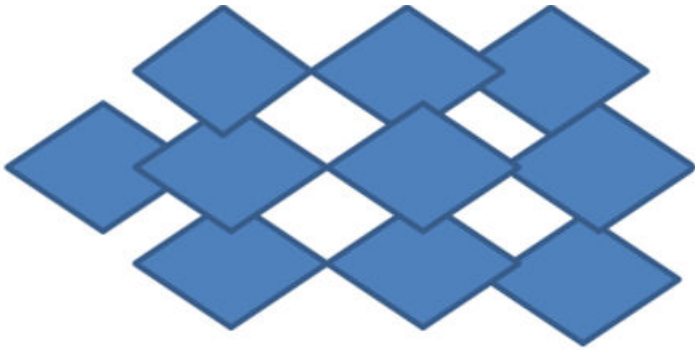

Figure 4: Structure of Inorganic Nanoparticle

Gold Nanoparticles

Gold nanoparticles (GNPs) are widely researched as nanocarriers due to their excellent conductivity flexibility of surface modification, biocompatibility, and simplistic preparation methods [78]. The unique physical and chemical properties include the gold core, nahotophysical properties and thiol linkages [79,80,81]. During GNPs preparation it can produce versatile ranges of nanoparticles [82-87].

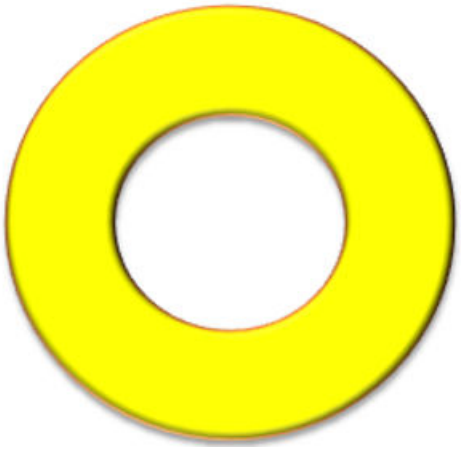

Figure 5: Spherical Structure of Gold Nanoparticles

Silver Nanoparticles

Silver nanoparticles are the most effective of the metallic nanoparticles against bacteria, viruses and other eukaryotic microorganisms, particularly due to the inherent inhibitory and bactericidal potential of silver, but also because of their good conductivity, catalytic properties, and chemical stability [88,89]. The key mechanisms of action of silver nanoparticles are the release of silver ions (which enhances antimicrobial activity), cell membrane disruption, and DNA damage. The reader is referred to a detailed review on the application of silver nanoparticles as virucidal agents [90,91,92].

Figure 6: Structure of Silver Nanoparticles

Other metallic nanoparticles

Various other metallic nanoparticles such as titanium,zinc,and copper, as well as metal oxide nanoparticles such as iron oxide, zinc oxide, and titanium dioxide have demonstrated specific antiviral activities. Others, like platinum nanoparticles, which are used for the detection of influenza virus, are yet to be evaluated [93-97].

Virology

All this nanoparticles are use for the treatment of different viruses [98-103].

	Company	Description	Mechanism of action	Indication	Approval year/ stage of development	Reference
Inflexal V®	Crucell, Berna Biotech	Virosomal (150 nm liposomes) vaccine	Mimicking native antigen presentation: Liposomes mimic the native virus structure, thus allowing for cellular entry and membrane fusion Retention of the natural presentation of antigens on liposomal surface provides for high immunogenicity.	Influenza	1997	Herzog, Mischler, Metcalfe, Bachmann andJennings [104-106]
Epaxal®	Crucell, Berna Biotech	Inactivated virosomal (liposome) vaccine	Unique mechanism of action which mimics the natural process	HAV	1999	Bovier [107]
PegIntron®	Merck	PEGylated interferon alfa-2b	Improved stability of protein through PEGylation	HCV	2001	Alconcel [108]
Pegasys®	Genentech	PEGylated interferon alfa-2b	Improved stability of protein through PEGylation	HBV, HCV	2002	Alconcel [108]

Influvac® Plus	Solvay Pharma/ Abbott	Virosome vaccine	Containing influenza surface proteins neuraminidase and hemagglutinin	Influenza	2005	Waknine [109]
FluquitTM (STP 702)	Sirnaomics Inc.	Short interfering RNA (SiRNA) therapeutic	Gene silencing	H5N1 and H1N1 influenza	Preclinical evaluation	Sirnaomics [110]
Cervisil® (STP 909)	Sirnaomics Inc.	Short interfering RNA (SiRNA) therapeutic	Gene silencing	HPV	Preclinical evaluation	Sirnaomics [110]
VivaGel® (SPL 7013)	Starpharma	Dendrimer	Lysine-based dendrimer with naphthalene disulfonic acid surface groups	HIV, HSV	Clinical trial (number: NCT00 740584) (approved for used against bacterial vaginosis)	Starpharma [111]
DermaVir	Genetic Immunity	Therapeutic vaccine	Synthetic plasmid DNA immunogen expressing 15 antigens, inducing significant expansions of the HIV-specific precursor/ memory T cell pool.	HIV	Clinical trial (number NCT00270205	Rodriguez [112]
Doravirine (MK-1439)	Merck	Solid drug nanoparticle formulation	Non-nucleoside reverse transcriptase inhibitor	HIV	Clinical trial (number: NCT02 549040)	Molina [113]
ARB-001467 TKM-HBV	Arbutus Biopharma	Wet lipid nanoparticle	Lipid particle containing three RNAi therapeutics that target three sites on the HBV genome	HBV	Clinical trial (number: NCT02 631096)	Seto [114]

CONCLUSION

We can conclude that nanoparticles have antiviral effect also. For its small size it can invade cell easily. The system use for the synthesis of nanoparticles are extremely retain its property on the nanoparticles. Shape is generally spherical. It can invade cell and help in the treatment. We are providing here a lot of result that can reduce silver, gold particles and make them nanoparticles. Spherical nanoparticles have antiviral effect proven in this review. They can cure many diseases. Once it prepared stored in a dark place. So that it stay good for a long time. If you want to cure viral diseases you can use plant extracts for the preparation of nanoparticles. Will you ever seen such a different type of nanoparticles synthesis and characterization medication and cure for the patient.

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