AUCTORES
Globalize your Research

International Journal of Clinical Case Reports and Reviews
Rajiv Kumar *

Open Access

Opinion Article

Nanomedicine, viral infection and cytokine storm

Rajiv Kumar*

NIET, National Institute of Medical Science, India.

***Corresponding Author:** Rajiv Kumar, NIET, National Institute of Medical Science, India.

Received Date: July 21, 2021 | **Accepted Date:** September 15, 2021 | **Published Date:** September 20, 2021

Citation: R Kumar. (2021). Nanomedicine, viral infection and cytokine storm. *International Journal of Clinical Case Reports and Reviews*. 8(4); DOI:10.31579/2690-4861/156

Opinion

Recently, emerged outbreaks of various viral infections, including severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), MERS-CoV, and ZIKA infections, are fatal for human life. These life-threatening infections to public health pointed out as a major cause responsible for initiating severe diseases globally. These viral infections heightened the morbidity rates and thus, it is a deadly fear to human life. Researchers left no stone unturned for searching newer therapeutic targets and remedies to treat these viral infections and outbreaks. Simultaneously, some of the researchers have gained success in the discovery of an efficient treatment and development of an effective vaccine [1]. In view of that, numerous developments have been made for innovating nanotherapies, which can treat viral infection and few of them are written off as nanomedicine, have been become reality. These freshly designed nanotherapeutics utilized in different formulations as per their acclaimed title role. Moreover, these nanoscale remedies easily applied in the different forms and phenomenon for prevention, treatment, diagnosis, and vaccination of the aforementioned infections and outbreak. It was specifically reported that the quantum dots are playing a magnificent role as biosensors and can apply for diagnosis viral infection, including (SARS-CoV-2), MERS-CoV, and ZIKA viral infections (Fig 1).

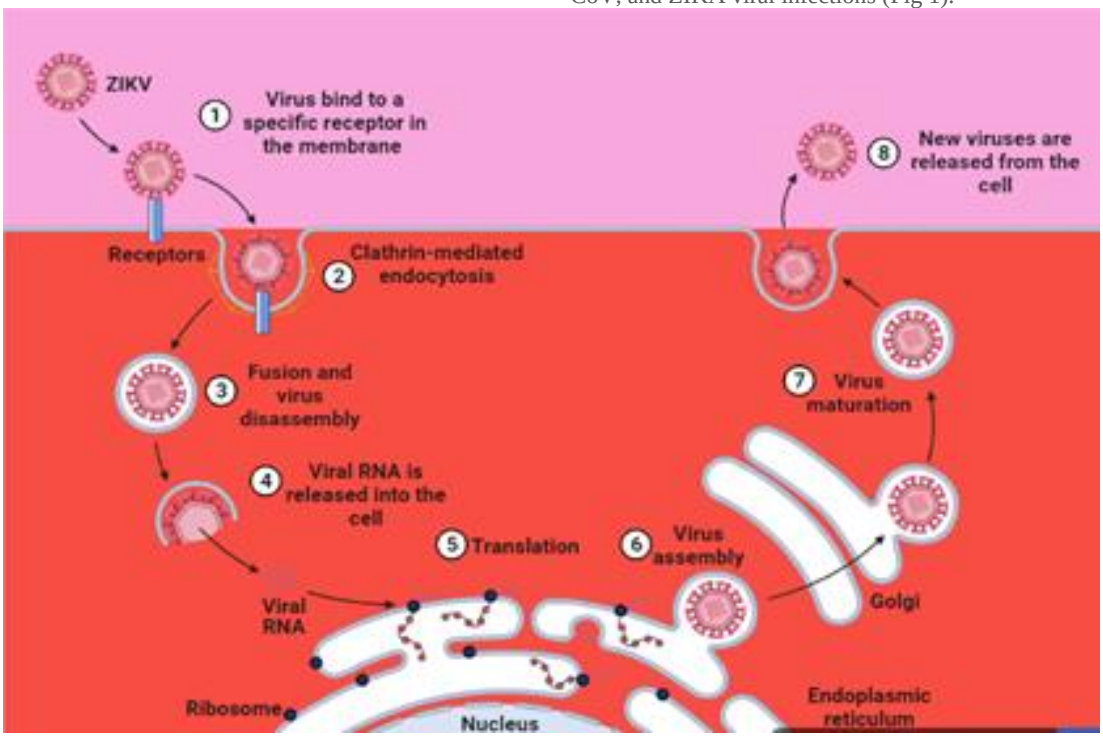

Figure 1: *An illustration of life cycle of viral infection (ZIKA Virus).*

Liposomes, micelles, lipid nanoparticles, metallic and polymeric nanoparticles are various other types of nanomaterials were designed and prepared by nanotechnology, used as drug delivery vehicle, drug constituents, and in encapsulation too [2]. Nanotools and devices can

easily transport immunosuppressant drugs to the affected site efficiently. The delivered immunosuppressant drugs can control the cytokine storm and settles it down before gaining a dangerous stage. At this juncture, the engineered nanotools and devices enhanced immune responses simultaneously and specifically prompt pharmacological impact on location of the diseased cells, and tissues. Therefore, nanomedicine is extensively acclaimed as potential probe agents in detecting and treating coronavirus 2 (SARS-CoV-2), MERS-CoV, ZIKA and other viral infections. These novel nanotherapeutics reduced inflammation and controlled fulminant cytokine storm when COVID-19 infections transpired [3]. The various immunological phases were identified by the decrease of CD^{4+}, CD^{8+}, T-lymphocytes (lymphopenia), and CD^{4+} cell expression of INF-γ. The other important characteristics of it, are the high concentration of tumor necrosis factor-alpha (TNFα), cytokines Interleukin-6 (IL6), and IL-10. While IL-10 induces anti-inflammatory effects, the concentration of pro-inflammatory mediators increased and finally it suppressed immunity [4]. The mechanisms of these routes of physiology transpired cytokine storms. Lymphopenia initiates some response to promote neutrophils and macrophages. These transformations overrun the physiology of the lungs and instigated severe damages in various forms. The distressed physiology of the routes and functioning styles of it is standardized and as well the initiation routes of juxtaposed endothelial tissue were also tracked. Phagocyte chemo-attractant cytokines (CCL2, CCL3, and CCL4) can be detected in the respiratory tract and was considered as the main component responsible for enhancing cytokine storm [5]. Various multifunctional nanomaterials are capable to catalyse immunomodulatory and cytokine-binding properties effectively to quench the cytokine storm [6]. At the time of COVID-19 outbreak and other dangerous infections emerged in excessive strength promote cytokine storm. Nanoscale tools and devices can control or stop chemokine intracellular signaling and the activity of cognate receptors [7]. Dys-regularisation and excessive assembly of multiple pro-inflammatory cytokines is considered as the key symptoms that instigated throughout coronavirus infection [8]. A novel therapeutic can only be applied in stopping the expansion of cytokine storms and it can easily be able to reduce the number of phases of cytokines activation and formation effectively.

Dysfunctional macrophages are the key components of cytokine storm expansion, and therefore, nanotherapeutic intervention is a good option to target these specific routes to check the progression of the cytokines [9]. These strategies will be a more feasible and reasonably approach comparatively macro-scale remedies. Notable nanotherapeutics inhibit the cytokine, and easily stop interrelated excessive proinflammatory responses. The authors are covering the impactful profiles and effectiveness of macrophage-targeted nanomedicines, and the same phenomenon can be utilized to hinder the frequency of cytokine storms and to intersperse pro-inflammatory responses [10]. These cytokines present in the cells and tissues in the form of small proteins enable cell communication routes and disturb the immune systems [11]. At the stage of SARS-CoV-2 infection, the cytokine storms enter the lungs and later on induced damages [12]. These newly originated features initiate inflammation, and uncontrolled stages of it lead hyper-inflammation and gained a dangerous stage. Nanotherapeutics are utilized to inhibit inflammation, cytokine storms and in the end, for treating SARS-CoV-2 by adjusting the immune response associated with the existence of the virus. Indeed, nanotheranostics are the best remedies notified for diagnosis and therapeutics of SARS-CoV-2 and MERS-CoV infection. Thus these therapies are also be highlighted as immunosuppressant remedies [13]. Notable clinical applications of nanotherapeutics are effectively considered as good in the field of immunological, and in controlling the translational barriers. For example, porous nanomaterials can reduce the effect of cytokines by absorbing into the porous network in a localized area, but e few of the routes of clearance can reduce their efficacy in vivo. Liposomes and other nanoparticles (gold or silica) demonstrated their potential as drug carriers with perfect delivery to control cytokine, additionally, their surface functionalization can bind various molecules and enhance bioavailability (Fig. 2). Nanotechnological devices and tools can spectacle cytokine levels and that is why it considered the best option for clinical diagnosis with high therapeutic efficacy [14]. These remedies can target alveolar epithelial cells for inhibiting any cellular processes.

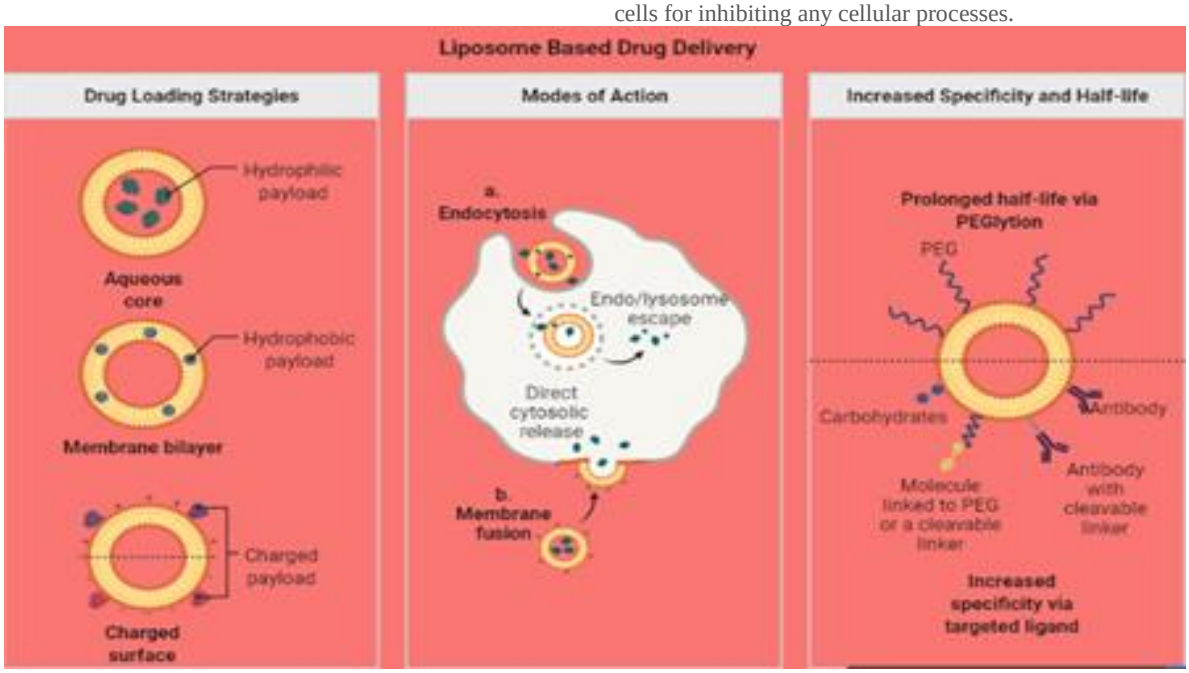

Figure 2: *An illustration of liposome drug delivery strategy.*

Dysregulation is the only process and considered as the main option, which can increase the possibilities that can trigger immune responses. These remedies have the potential to repair the dysfunctional of related processes, which can counter the imbalance initiated by the cytokine

storm [15]. Instigated inflammation initiates a pathophysiological mechanism responsible for promoting thrombosis [16]. These circumstances underlined the need for specific remedies, which will have displayed antibiotics, antivirals, and anti-inflammatory effects, can be considered for treating SARS-CoV-2 infection [17]. The design of nanomaterials can act as an immune modulator, which can control stimulating or suppressing biological activities of immune responses, utilized in vaccine development to treat SARS-CoV-2 or can counteract the cytokine storm separately [18]. Several modifications have been done for improving pharmacological drug properties. The nanoscale devices and tools can be applied as novel drug carriers and recovering agents. To decrease or deactivate or destroy the impact of any virus or SARS-CoV-2 infection, or to stop the side effects of several other harmful viral infections having in-built features (binding, entry, replication, and budding) of such viruses. Several nanodevices and nanotools were applied, discussed, and referred to in just now published scientific reports and articles [19]. Therefore, multifunctional nanomaterials and nanotechnology are useful for treating sars-Cov-2 virus infection [20]. These remedies displayed strong effectiveness at the time of severe prognosis, especially in weaker individuals, and are effective in acute respiratory distress syndrome. These features are underlined as major causes which were identified in the later stages of the disease, are responsible for the death or increase its rate. These nanoscale tools and devices can easily identify SARS-CoV-2 via smart and innovative nano-based in-built technologies [21]. It is concluded here that these multifunctional bioengineered nanomaterials can be useful in the detection, prevention, and treatment of viral infections.

Acknowledgments

Author (Rajiv Kumar) gratefully acknowledges his younger brother Bitto for motivation. The author acknowledges bio render for providing the facility to illustrate the diagrams (Fig. 1) and again acknowledges the same.

Availability of data and materials

Wherever necessary, relevant citations are included in the reference section.

Competing interests

The author has declared that no competing interest exists.

References

1. Liu J, Wan M, Lyon CJ, Hu TY. (2020). Nanomedicine therapies modulating Macrophage Dysfunction: A potential strategy to attenuate Cytokine Storms in severe infections. Theranostics. 10: 9591-600.
2. Alaarg A, Jordan NY, Verhoef JJF, Metselaar JM, Storm G, Kok RJ. (2016). Docosahexaenoic acid liposomes for targeting chronic inflammatory diseases and cancer: An in vitro assessment. Int J Nanomedicine. 11: 5027-5040.
3. Al-Hatamleh MAI, Hatmal MM, Alshaer W, et al. (2021). COVID-19 infection and nanomedicine applications for development of vaccines and therapeutics: An overview and future perspectives based on polymersomes. Eur J Pharmacol. 896.
4. Valizadeh H, Abdolmohammadi-vahid S, Danshina S, et al. (2020). Nano-curcumin therapy, a promising method in modulating inflammatory cytokines in COVID-19 patients. Int Immunopharmacol. 89.
5. Wu J, Han Y, Zou X, et al. (2019). Silica nanoparticles as an enhancer in the IL-1β-induced inflammation cycle of A549 cells. Immunopharmacol Immunotoxicol. 41: 199-206.
6. Alaarg A, Zheng KH, van der Valk FM, et al. (2016). Multiple pathway assessment to predict anti-atherogenic efficacy of drugs targeting macrophages in atherosclerotic plaques. Vascul Pharmacol. 82: 51-59.
7. Coperchini F, Chiovato L, Croce L, Magri F, Rotondi M. (2020). The cytokine storm in COVID-19: An overview of the involvement of the chemokine/chemokine-receptor system. Cytokine Growth Factor Rev. 53: 25-32.
8. Mahmudpour M, Roozbeh J, Keshavarz M, Farrokhi S, Nabipour I. (2020). COVID-19 cytokine storm: The anger of inflammation. Cytokine. 133.
9. Witika BA, Makoni PA, Mweetwa LL, et al. (2020). Nano-Biomimetic Drug Delivery Vehicles: Potential Approaches for COVID-19 Treatment. Molecules. 25.
10. Ahmad S, Raemy DO, Loader JE, et al. (2012). Interaction and localization of synthetic nanoparticles in healthy and cystic fibrosis airway epithelial cells: Effect of ozone exposure. J Aerosol Med Pulm Drug Deliv. 25: 7-15.
11. Jastrzębska AM, Vasilchenko AS. (2021). Smart and Sustainable Nanotechnological Solutions in a Battle against COVID-19 and Beyond: A Critical Review. ACS Sustain. Chem. Eng. 9: 601-622.
12. Wang J, Kaplan N, Wysocki J, et al. (2020). The ACE2-deficient mouse: A model for a cytokine storm-driven inflammation. FASEB J. 34: 10505-10515.
13. Copaescu A, Smibert O, Gibson A, Phillips EJ, Trubiano JA. (2020). The role of IL-6 and other mediators in the cytokine storm associated with SARS-CoV-2 infection. J. Allergy Clin. Immunol. 146: 518-534.
14. Benani A, Ben Mkaddem S. (2020). Mechanisms Underlying Potential Therapeutic Approaches for COVID-19. Front. Immunol. 11.
15. Huang Q, Wu X, Zheng X, Luo S, Xu S, Weng J. (2020). Targeting inflammation and cytokine storm in COVID-19. Pharmacol. Res.
16. Jafarzadeh A, Chauhan P, Saha B, Jafarzadeh S, Nemati M. (2020). Contribution of monocytes and macrophages to the local tissue inflammation and cytokine storm in COVID-19: Lessons from SARS and MERS, and potential therapeutic interventions. Life Sci. 257.
17. Daneshkhah A, Agrawal V, Eshein A, Subramanian H, Roy HK, Backman V. (2020). Evidence for possible association of vitamin D status with cytokine storm and unregulated inflammation in COVID-19 patients. Aging Clin Exp Res. 32: 2141-2158.
18. Song P, Li W, Xie J, Hou Y, You C. (2020). Cytokine storm induced by SARS-CoV-2. Clin. Chim. Acta. 509: 280-287.
19. Ahmed F. (2020). A Network-Based Analysis Reveals the Mechanism Underlying Vitamin D in Suppressing Cytokine Storm and Virus in SARS-CoV-2 Infection. Front Immunol.
20. Hong E, Halman JR, Shah A, et al. (2019). Toll-like receptor-mediated recognition of nucleic acid nanoparticles (NANPs) in human primary blood cells. Molecules.
21. Tarun T, Kumar S, Johnson J, Chockalingam A. (2021). A case report on transient cardiomyopathy with cytokine storm in SARS-CoV-2. Eur Hear J - Case Reports.