

## Nanotechnology For Mitigating Impact Of COVID-19

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### Abstract

This review article aims to create awareness towards COVID-19 epidemic and develop a basic responsibility in human beings to control and stop the transmission of COVID-19. It has been highlighted that disaster is imminent if we play with nanostructures unknowingly. The effect of COVID-19 on mankind and its detection and transmission have also been discussed briefly. The protection guidelines including treatment procedures have been illustrated. The utilization of nanoparticles to detect and cure COVID-19 has been described.

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**Keywords:** COVID-19; nanoparticles; disaster; transmission; diagnosis.

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### 1. Introduction

A transmittable disease COVID-19 (Corona virus disease 2019) is instigated by corona virus 2 (SARS-CoV-2 or SC-2), an extreme acute respiratory syndrome. A large number of countries have been affected due to the transmission of SC-2 with a huge amount of dismissing to date. To control the situation, our existing technology and medical facilities need to utilize together in terms of nanotechnology and nano medicine [1-2]. The current scenario demands to bring an effective and safe sensor to detect viruses present in the environment and living bodies (humans, animals and plants/fruits/vegetables). Sensors fabricated using nano materials may have the capability to sense very low concentrations of bacteria and viruses, as tested by Rathore et al. [3] towards rotten lemon using nickel ferrite nanoparticles and achieved excellent results in terms of sensitivity (%). The enormous variety of efficient gas sensors have also been designed and tested using nanomaterials and nanocomposites for reducing and flammable gases [4-6]. Nowadays, a nano filtered face mask is being designed by nanofibers to enhance filtering efficiency. Those nanofibers coated face masks are eco-friendly and reusable, which can solve the problem of shortage as well. For many years, nanotechnology is the potential field to diagnose and treat viral and bacterial infections [7-11]. Ji et al. [12] demonstrated the feasibility of detecting severe acute respiratory syndrome-associated coronavirus (SARS-CoV) using microcantilever technology by showing that the feline coronavirus (FIP) type I virus can be detected by a microcantilever modified by feline coronavirus (FIP) type I anti-viral antiserum. Wang et al. [13] reported that the

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two-dimensional gold nanoislands (AuNIs) functionalized with complementary DNA receptors can perform a sensitive detection of the selected sequences from severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) through nucleic acid hybridization. For better sensing performance, the thermo-plasmonic heat is generated on the same AuNIs chip when illuminated at their plasmonic resonance frequency. The localized PPT heat is capable to elevate the in situ hybridization temperature and facilitate the accurate discrimination of two similar gene sequences. In this review article, the authors have included safety guidelines for transmission control and the best possible treatment for suspected and infected people in the current scenario. It has also brought to notice that people unknowingly invited disaster by playing with nanoparticles as created by nature. Appropriate use of nanoparticles may bring many efficient technologies to the fore to handle this disaster in terms of nanosensors and nanomedicine.

## 2. The virus nanoparticles: Creativity of nature

The significance of viral nanoparticles has been demonstrated to several generations of students during many years of teaching nanotechnology and nanomedicine by many experts. One category of nanoparticles is more intelligent, very attractive and proficiently designed by nature. Authors have often stressed with enthusiasm about their architecturally attractive features at the nano-level, and biological deception in passing their genetic material to objective cells and capture them to prompt proteins. In the area of immunotherapy, gene therapy and vaccinology, the 'Viruses' are progressive architecture. Researchers are tailoring and designing a variety of viruses to deliver molecules and genetic information smartly. Nonetheless, Authors have to confess that they can't support but endure oddly remorseful about their previous thoughts and lecture summaries over the last few days, during the lockdown. As authors slowly glimpse to know regular efficient numbers of 'confirmed cases,' 'recovered cases,' and 'deaths', humiliation instigates to take over. How these stunning nanostructures may cause great damage and destruction to humans? How can such a nano-level architect turn into a harsh creature so quickly? [14,15].

## 3. Structure of Coronavirus

Coronavirus enclosed, positive-stranded RNA viruses with the largest genome, normally extending from 27 to 32 kb. The nucleo-capsid protein covers the genome in the form of a helical capsid which is enclosed again by protein. There are three structural proteins linked with the virus as an envelope such as (i) membrane protein (ii) envelope protein (iii) spike protein. The membrane protein and envelope protein are used to make virus assembly, while the spike protein facilitates virus entry into host cells. Many times coronavirus also encrypts an enclosure linked by hemagglutinin-esterase protein. The spike protein makes large flanges over the surface of the virus, because of those flanges coronavirus looks like a crown. Therefore, its name kept corona (crown means corona in Latin) [16-20].

## 4. The social aspect

Scenarios and strategies for reacting to a possible deliberate or accidental virus epidemic have long been studied and created by experts and international committees. There were also reported that the possibility of spreading infectious antibiotic-resistant bacteriological strain or virus was nearly inevitable due to our increasingly developed animal farming and cultivation practices, environment alteration, extremely crowded urban zones and global migration, which has fashioned an open environment. Not only it has been told, but also warning sign has been given in previous 2 decades, containing (i) avian influenza virus in 1997, Hong Kong, (ii) serious acute respiratory syndrome (SARS) coronavirus in 2002, China, (iii) swine influenza virus in 2009, Mexico, and (iv) coronavirus in 2012, Saudi Arabia as the Middle East Respiratory Syndrome (MERS).

Such amazing nanostructures, which syndicate structural intricacy with biological effectiveness as shown in Figure 1, were all initially transferred to a human being from various animal species; unfortunately, they are extremely infectious through people to people transmission, which miserably produced numerous demises. Regrettably, it has not collectively understood before the time that the danger was obvious, impending and important. People also failed to ensure that in the case of an outbreak the preparations and instructions, formulated by specialists, which could be followed swiftly and efficiently. Yes, a multiplicity of human inefficiencies is encountered with any successful viral infection. Consequently, the human being has been overbeaten by the nanostructures produced by nature [21-23].

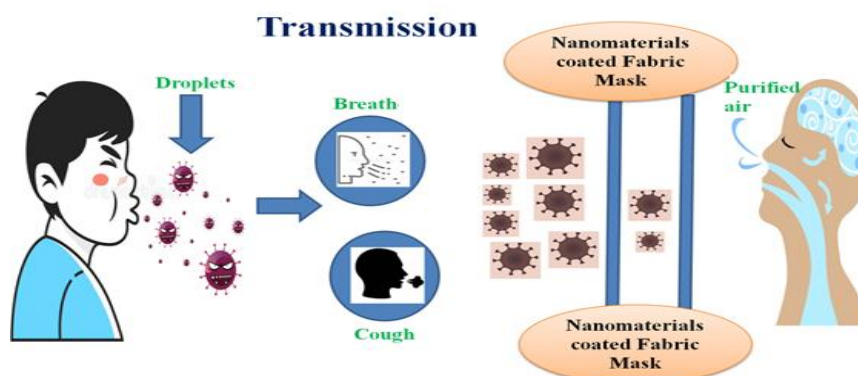


Fig. 1. Basic transmission of coronavirus from human to human.

## 5. Study of growth rate in India

Covid-19 growth stated in India January 2020 in terms of patents and then transmitted the high growth rate but according to the population is the topmost population in the world and this level of growth is too much. The government of India well planned and followed by strictly lockdown and invention of “JANTA CURFEW” then started the total lockdown so the effect of Covid-19 is lesser than other countries. The total cases have been found around 6000000 till 30 September 2020 [1-2].

## 6. The technical aspect

The important prerequisite is needed to make the technical actualities accurate with reliability. The advantage must be taken from our laboratory techniques, mechanization including effective modelling approaches to discover technical information about COVID-19. SC-2 is identical to coronaviruses. It has been earlier explained that it attaches cell receptors to angiotensin-I transforming into enzyme-2 (ACE2), and is exceedingly infectious between human beings, even at hidden infection phases. It is recognized that SC-2 affects the upper respiratory system, and particularly the lung epithelium, via basic symptoms or through myocardial effects. The most susceptible infected people are male than female. Eventually, almost 80% of infected people are suffering from minor symptoms, which are known as asymptomatic. From them, 15% require hospitalization and 5% progress an unadorned illness and require medical care. It cannot be understood that how simply, SC-2 may transform into altered serotypes. We don't know that how SC-2 cell internalization and viral transduction depend on manifold infections, temperature and virus progeny compeers? It is also not clear how SC-2 effects on immunity power in infected persons differently. To understand the complete phenomenon for safety, specific guidelines regarding COVID-19 infections must be defined and followed by national and international health agencies [22-25].

## 7. Protection from COVID-19

All over the world, people are contributing to the fight against the present CoVID-19 pandemics spread. The government has titled the name as “Corona Warrior”, those are doctors/medical staff, police, sweepers, cleaners and food distributors. Recently homemade washable mask from cotton fabric has also been developed. The main material of the mask is a cotton fabric that comforts the person from heat and sweat of the season. The thickness of the fabric was critically chosen and used in double-layer to block the tiny respiratory aerosol particles (fine droplets of a sneeze) which are of 8-12 $\mu$ .

The triple/double pleats inserted horizontally in the mask spread it to cover the vital parts of the face. It also gives bulging narrow space near the mouth and nostrils to speak and breathe comfortably as shown in Figure 2. It is also proposed to increase the filtration efficiency by inserting thin layer/film of nanofibers of Polymer/TiO<sub>2</sub>, ZnO or BiOX

(X= Cl, Br and I) nanocomposites between the two layers of cotton fabric. This will enhance the antiperspirant and antibacterial activity of cotton fabric [8-11, 26, 27].



Fig. 2. Nanoparticles coated fabric mask.

## 8. Detection of COVID19

The most significant and sensitive technique RT-PCR (Real-Time Polymerase Chain Reaction) has been utilized to detect COVID-19. RT-PCR can detect RNA of viral particle released by coronavirus [28]. This virus is generated by strain. It takes lots of processing time and needs qualified and well trained medical/research staff. Recently, LSPR (Localized Surface Plasmon Resonance) technique has been emerged out as sensing phenomenon for measuring strain [13]. This technique demonstrates a higher order of precision, pace and sensitivity during detection of COVID-19 RNA.

RT-LAMP (Reverse transcription loop-mediated isothermal amplification) technique has also been developed recently to detect SC-2 [29]. This technique doesn't need any special laboratory tools. It is processed at a single operating temperature. It comprises helicase-dependent amplification, recombinase polymerase amplification and loop-mediated isothermal amplification. Point-of-Care testing is a basic primary diagnose technique, in which infected people can be recognized without using any centralized laboratory facilities. A very good example of point of care approach is lateral flow antigen detection to detect SC-2 and diagnose COVID-19 [29-30].

## 9. Spread of COVID-19

Initially, the CoVID-19 started from Wuhan's Huanan Seafood Wholesale Market, China. The main phenomenon was supposed to be the animal-to-human transmission. Even though, this transmission progression was not correlated with successive events. Consequently, it was recognized that the COVID-19 could also be transferred from human to human. Hence, the infected people became the most common cause of COVID-19 dispersion. Before, people were also not aware that the symptoms arise very late and the possibility of transmission appears uncommon. After all, it came in a movie that this virus may be transmitted from person to person that remains asymptotically as shown in Figure 1. The current situation illustrates that isolation is the best way to hold this disaster, which is known as 'social distancing' [31-32].

## 10. The initial guidelines

COVID-19's clinical range from no symptoms/few symptoms to severe respiratory conditions require immediate treatment in mechanical ventilation and an intensive care unit (ICU), to sepsis, septic shock, and multiple organ dysfunction syndromes (MODS) and systemic manifestations. Huang et al. demonstrated in one of the first studies on the disease that the number of 41 patients suffered from dry cough, fever, dyspnea and malaise. In each case, pneumonia was found by computerized tomography (CT) scans of the chest. Around one-third of those (13.32%)

required ICU treatment, and 6 (15 %) fatal cases were registered. Li et al. published a case study in the New England Journal of Medicine (NEJM) on January 29, 2020, encapsulates the first 425 cases reported in Wuhan. Data show that the middle age of the patients was almost 59 years, with a range of between 15 and 89 years. Therefore they did not disclose any clinical cases in children under the age of 15. There were no major differences between the sexes (male 56 %). Chinese CDC clinical and epidemiological data and 72,314 case reports (suspected, confirmed, reported and asymptomatic cases) were published in Journal of the American Medical Association (JAMA) (Feb 24, 2020), offering a significant example of the Chinese outbreak's epidemiological curve. There were 62% confirmed cases, including 1 % asymptomatic case, but lab-positive (viral nucleic acid test). Besides, the average death case rate was approximate 2.3 % (on reported cases). The death cases were mostly ageing patients of nearly 80 years old (about 15%) and 70 to 79 years old (about 8.0%).

About half of vital patients (49.0%) died those were suffered by pre-existing diseases like oncological diseases, cardiovascular disease, chronic respiratory disease, and diabetes. While 1 % of patients were 9 years of age or younger, there were no fatal cases in this category [16-19].

The symptoms have been divided into three categories.

- a) Mild disease: in this category, 81% of people were affected by non-pneumonia and mild pneumonia.
- b) More disease: in this category 14% people suffered by respiratory rhythm 30/min (shortness of breath), which is known as 'Dyspnea', lung infiltration > 50% within 24 to 48 hours, P/F < 300 (the ratio of blood pressure of oxygen to the amount of oxygen supplied).
- c) Critical disease: in this category, 5% of people were suffered from breathing failure, septic shock, multi-organ dysfunction (MOD) or failure (MOF).
- d) Data obtainable from health policy agencies reports and directives allow the medical indexes of the disease to be divided according to the severity of the clinical images. The COVID-19 has created mild, sensible and serious illness [1].

#### *Moderate Pneumonia*

Without signs of extreme pneumonia, simple respiratory symptoms like cough and dyspnea (tachypnea in kids) are present.

#### *Severe Pneumonia*

Fever is associated with extreme dyspnea, respiratory difficulty, tachypnea (>30) and hypoxia (SpO<sub>2</sub> <90 % in room air). Nevertheless, the fever symptom needs to be carefully interpreted because it may be mild or even absent, even in extreme types of the disease. Cyanosis can occur in infants. The diagnosis is clinical in this context, and radiological imaging is used to rule out complications.

### **11. Potential Treatments and capacity building**

To cure COVID-19, a particular approved vaccine or antiviral treatment is not available till now. The diagnosis is symptomatic and oxygen therapy is the core medical method for extremely infested patients. In cases of septic shock management, hemodynamic support may be required, while mechanical ventilation is needed for respiratory failure refractory to oxygen therapy. The WHO issued a paper on January 28, 2020, describing WHO recommendations and medical outcomes achieved from the treatment of previous HCoV epidemics. This paper describes many phases for identifying and categorize patients with severe desperate respiratory diseases such as (i) infection prevention and management strategies, (ii) early intervention and tracking therapy, (iii) recommendations for laboratory diagnosis (iv) Managing respiratory failure and ARDS, (v) septic shock management, (vi) emergency prevention, (vii) treatment and (viii) pregnant patient considerations [19-22].

The latest approach to curb the spread of cases is preventive measures. The basic guidelines have to be followed by individuals to control reproduction number and keep it less than one. The following general recommendations have been given by the WHO and other organizations:

- a. Keep away from direct contact with people those are affected by acute respiratory infections.

- b. Wash your hands frequently, mainly after interacting with infected atmosphere and people.
- c. Avoid interaction with farms or wild animals without safety.
- d. Individuals with acute airway infection symptoms should keep their distance, cover coughs or sneezes with disposable tissues or clothes and wash hands.
- e. Strengthen, in particular, the implementation of stringent hygiene procedures for the prevention and control of infections in emergency medicine departments.
- f. Immunocompromised people should avoid public meetings.

The basic and crucial technique for the people to follow is to wash their hands regularly and use portable hand sanitizer after engaging with a potentially polluted area to prevent contact with their face, hands and mouth. Health care staff that cares for infected individuals should use touch and airborne measures that include EPPs such as N95 or FFP3 masks, eye protection, gowns, and gloves that avoid pathogen transmission [18]. Due to nonspecific symptoms at the early stages, all kinds of infectious and non-infectious respiratory disorders must be included in the diagnosis techniques. Those respiratory disorders are influenza, adenovirus, HmPV (human metapneumovirus), RSV (Respiratory syncytial virus), para-influenza and common cold (Rhinovirus) [17, 18].

## 12. Role of Nanotechnology in fighting COVID-19

There is no specific medicine, treatment and vaccine to cure COVID-19. The basic treatment is provided to enhance the immune system. So in the current scenario, nanomedicine/nanodrugs may bring a great revolution with their surprising performance towards SC-2. The size of SC-2 is in a nanometer, so it is also like nanoparticles. It is being assumed that biocompatible nanoparticles can interact with spine-like proteins and bind them by exposing infrared light. Subsequently, it can disrupt the viral structure. Due to which, the ability of multiplication of the virus and its genome can be stopped. The new strategy syndicates diagnostic and therapy together with identification and neutralization known as ‘the agnostics’. In medical science, nanoparticles are being used to attack over pathogens, which is the cause of tuberculosis and influenza.

It has been to notice that surface-modified and functionalized biocompatible nanoparticles have the capability to detect viruses, pathogens and bacteria. Those functionalized nanoparticles can pass through the bloodstream inside the body without disturbing other functions of organs [8, 22-28].

## 13. Utilization of nanoparticles for the detection and treatment of COVID-19

### 13.1. Silver nanoparticles

Silver nanoparticles have been approved by FDA (Food and Drug Administration) for medical use to cure wound due to their antimicrobial properties [33]. From the literature survey, it has come in the knowledge that silver nanoparticles have antibacterial and antiviral effects and can affect specifically on influenza viruses. Silver ions are more effective than silver nanoparticles as antibacterial activity. Due to catalytic, sensory, and above-mentioned properties, silver nanoparticles are being used in water treatment, textile manufacturing, chemical industry, medicine, pharmaceutical, etc. [34]. A variety of conventional methods are available to synthesize silver nanoparticles with different physicochemical properties with varying particle size [35-37].

### 13.2. Gold nanoparticles

A diagnostic test based on gold nanoparticles has been developed by Zagorovsky et al. [36]. They used DNA and gold powder with a few drops of reagents. This diagnostic test can detect most of the infectious diseases [38]. In this concept, the combination of gold nanoparticles and DNA provides a blue signal in the occurrence of the target gene, but the system has been designed like a DNA probe that is snipped away from the gold nanoparticles with a red signal for a positive sample. After the performance, no sanitization is required. In parallel, numerous tests have been diagnosed with accuracy using this system [38, 39].

Gold nanoparticles possess excellent size-dependent optical properties, due to which they are very promising

candidates to detect pathogens including viruses. For microbial detection, the colloidal gold nanoparticle conjugated with the antibodies based membrane chromatography assays has been designed, which is known as immune-chromatographic strips. These strips are cost-effective, simple and fast performer for microbial detection with less laboratory equipment [39].

### 13.3. *TiO<sub>2</sub> nanoparticles*

Besides, the effect of NPs on oxidative stress conditions in animal models or at the cellular level is generally considered to be common endpoint studies to detect NPs toxicity profile. In vivo and in vitro research also plays a key role in understanding the mechanisms of oxidative stress causing NPs. Previous studies have shown significant accumulation of titanium dioxide NPs (TiO<sub>2</sub>-NPs) in mice's lungs after a successive 90-day intra-tracheal administration of TiO<sub>2</sub> NPs for instance. The TiO<sub>2</sub>-NPs expressively increased the level of ROS accumulation, inflammation, lipid peroxidation, and also reduced the competency of antioxidants in the lungs. The NPs could produce ROS followed by oxidation of antioxidant molecules, thus affecting the respiratory system and related pathobiological activities, including pulmonary inflammation and genotoxicity [40]. For another study, polylysine-linker was used to manufacture nanocarriers of functionalized titanium dioxide (TiO<sub>2</sub>) DNA that targeted the 30 non-coding influenza viral region. Such NPs reached cells without the assistance of transfection agents and significantly inhibited in vitro influenza A [41].

### 13.4. *ZnO nanoparticles*

Zinc oxide (ZnO) is one of the most used metallic NPs and has been incorporated into a variety of commercial products, including food preservation, medical materials, portico paints and personal care products. Due to their high antimicrobial activity, strong catalytic capabilities and specific optoelectronic properties, metallic nanoparticles (NPs) have been used intensively in many fields, such as catalysis, gas sensing, electronics, and environmental remediation [42]. Among the environmental variables that impact the fate and actions of ZnO NPs, light deserves significant attention due to its effects on reactive oxygen species (ROS) generation with emissions from ZnONPs. Therefore, it is well known that fungi have been shown to control the decomposition of the leaf litter among microbial decomposers, and are more susceptible to pollutants than bacteria, providing an effective model for evaluating contaminant effects on complex ecological systems [43].

### 13.5. *BiOCl nanoparticles*

BiOCl is a kind of photocatalytic material that has strong charging separation features. Its method of preparation is simple and flexible, and its raw materials are readily available and at a low cost [27]. In recent years, several researchers have conducted a lot of studies on BiOCl preparation, controlling photocatalytic efficiency and related theories and have made considerable progress. Researchers have enhanced BiOCl's light absorption ability and encouraged the separation and transfer of photogenerated charge through doping, creating vacancies, regulating internal electrical fields, supporting co-catalysts, building composites with semiconductors, and using sensitizers, thereby enhancing BiOCl's photocatalytic efficiency [44-46]. Photocatalytic reactions typically occur on the substrate surface, so the photocatalytic output is closely related to the material's surface properties. The formation of oxygen vacancies is regarded as an important method for modifying the surface properties of materials, and there are two key characteristics in regulating BiOCl's photocatalytic performance. One is that BiOCl's electronic properties can be modulated by oxygen vacancies, thus increasing light absorption and charge transfer [47].

### 13.6. *Carbon nanotubes (CNT)*

Carbon nanotubes were first used in the fields of nanotechnology as additives to various structural materials for electronics, optics, plastics and other materials. They have been introduced in therapeutics in pharmacy and medicine since the early 21st century for the drug delivery system. CNTs can adsorb or conjugate a wide range of therapeutic molecules (drugs, proteins, antibodies, DNA, enzymes, etc.) thanks to their high surface area, excellent chemical stability, and rich electronic polyaromatic structure [48]. They are an excellent tool for drug delivery by penetrating the cells directly and holding the drug intact without metabolism during transport throughout the body. Many studies have shown that these molecules are transmitted more efficiently and safely into cells when bound to CNTs than with

conventional methods. This exciting breakthrough has paved the way for drug formulations that are entirely different from conventional approaches used before in the pharmaceutical industry and have fundamentally changed anterior pharmacology concepts [49].

Genotoxicity, whether primary or secondary, is a major concern associated with the delivery systems mediated by NPs. Genotoxic molecules or NPs impact directly by interacting with DNA structures or cellular division constituents such as microtubule spindles or centromeres [50]. The carbon nanotubes (CNTs) have been interacting directly with DNA assemblies. This suggested that either in vivo (animal models) or at cellular levels, CNTs can cause genotoxicity. Studies have shown that pulmonary administration of multi-walled CNTs induced genotoxicity by inducing chronic inflammation, leading to persistent oxidative stress [51]. Fibrosis is regarded in the pulmonary sites as a measure of accumulation of inhaled NPs and induces rare modes of pulmonary inflammation such as eosinophilia. In one of the trials, single-walled inhaled CNTs resulted in multifocal granulomatous pneumonia and fibrosis in the C57BL/6 male model treated [52].

#### 14. Conclusion

As the extent of damage done by this pandemic is yet to be ascertained, one thing is for sure that impact is going to last for a long time to come. The spread of the virus was so sudden that researchers did not have time to come up with a properly tested medication. The lockdown imposed in many countries delayed the spread of the virus exponentially thereby buying some time to build on capabilities to handle it better in the coming days. The world has made significant technological advances in the last centuries and it is time for all these technologies to come to the fore as a saviour of mankind. Nanotechnology is leading the way in this direction with many researchers using this as a tool for developing testing solutions. Nanosensors have already shown great ability to detect bacteria and viruses in the past. The same can be used in tackling this pandemic by developing easy to conduct test methods and also by using nanomaterials to make foolproof personal protection equipment. Researchers at various levels have agreed to collaborate to take the virus head-on. Significant outcomes have already started to emerge.

#### DECLARATIONS

**Funding:** Authors are thankful to UGC-DAE, CSR, Indore (Project no-CSR-IC/MSRSR-10/CRS-218/2017-18/1299) and SERB (Project no- EMR/2016/002156) for providing funds.

**Competing Interests:** The authors report no conflicts of interest in this work.

**Ethical Approval:** Not applicable

**Author contributions:** All authors contributed to data collection, drafting or revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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